

06-01-00

A

JC822 U.S. PTO
05/31/00

JC583 U.S. PTO
09/584936
05/31/00

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application	) <u>PATENT APPLICATION</u>
)
Inventor(s): Michael G. Kahn, M.D., Ph.D;	) Art Unit:
Michael Mischke-Reeds)
	) Examiner:
SC/Serial No.: Unknown)
)
Filed: Herewith)
)
Title: CLINICAL TRIALS MANAGEMENT SYSTEM)
AND METHOD)
)

**CERTIFICATE OF MAILING BY "EXPRESS MAIL"
UNDER 37 C.F.R. § 1.10**

"Express Mail" mailing label number: EL553343329US
Date of Mailing: May 31, 2000

I hereby certify that this correspondence is being deposited with the United States Postal Service, utilizing the "Express Mail Post Office to Addressee" service addressed to **Box PATENT APPLICATION, Assistant Commissioner for Patents, Washington, DC 20231** and mailed on the above Date of Mailing with the above "Express Mail" mailing label number.

Johann S. Mercado

Signature Date: May 31, 2000

(Signature)

UTILITY PATENT APPLICATION TRANSMITTAL LETTER UNDER 37 C.F.R § 1.53(b)

Box PATENT APPLICATION
Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Transmitted herewith for filing is the patent application identified as follows:

Inventor(s): Michael G. Kahn, M.D., Ph.D; Michael Mischke-Reeds

Title: CLINICAL TRIALS MANAGEMENT SYSTEM AND METHOD

No. of pages in Specification: 71; No. of Claims: 138.

No. of Sheets of Drawings: 26; Formal: , Informal: ✓ .

Also enclosed are:

- ☒ A Declaration for Patent Application.
- ☒ A Power of Attorney by Assignee.
- ☒ A Joint to Corporate Assignment and Recordation Form Cover Sheet.
- ☐ A certified copy of a priority application.
- ☒ A Statement Claiming Small Entity Status.
- ☒ An Information Disclosure Statement under 37 C.F.R. §1.56.

The filing fee pursuant to 37 C.F.R. §1.16 is determined as follows:

No. Filed	No. Extra	Rate Small Entity/ Other Than Small Entity		
Basic Fee		\$380.00 \$760.00	=	\$ 380.00
Total Claims	<u>138</u> - 20 = <u>118</u> *	\$ 9.00 \$ 18.00	=	\$ 1,062.00
Independent Claims	<u>15</u> - 3 = <u>12</u> *	\$ 39.00 \$ 78.00	=	\$ 468.00
First Presentation of Multiple Dependent Claim(s)	___	\$130.00 \$260.00	=	\$
Total			=	\$1,910.00

*If the difference is less than zero, enter "0".

- ☐ Please charge Deposit Account No. 06-1325 in the amount of \$____. A duplicate copy of this authorization is enclosed.
- ☒ A check in the amount of \$1,950.00 to cover the filing fee (\$1,910.00), and Assignment recording fee (\$40.00), if applicable, is enclosed.

✓ The Commissioner is hereby authorized to charge underpayment of any additional fees (including those listed below) or credit any overpayment associated with this communication to Deposit Account No. 06-1325. A duplicate copy of this authorization is enclosed.

✓ Any additional filing fees under 37 C.F.R. §1.16.

✓ Any patent application processing fees under 37 C.F.R. §1.17.

This application is filed pursuant to 37 C.F.R. §1.53(b) in the name of the above-identified Inventor(s).

— This application claims priority to an earlier-filed Provisional patent application, as set forth more fully in this application.

Please direct all correspondence concerning the above-identified application to the following address:

Warren S. Wolfeld
FLIESLER, DUBB, MEYER & LOVEJOY LLP
Four Embarcadero Center, Suite 400
San Francisco, California 94111-4156
Telephone: (415) 362-3800

Respectfully submitted,

Date:

May 31, 2000

By:

Brian I. Marcus
Reg. No. 34,511

FLIESLER, DUBB, MEYER & LOVEJOY LLP
Four Embarcadero Center, Suite 400
San Francisco, California 94111-4156
Telephone: (415) 362-3800

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application	)	<u>PATENT APPLICATION</u>
)	
Inventor(s): Michael G. Kahn, M.D., Ph.D;	)	Art Unit:
Michael Mischke-Reeds)	
	)	Examiner:
SC/Serial No.: Unknown)	
)	
Filed: Herewith)	
)	
Title: CLINICAL TRIALS MANAGEMENT SYSTEM)	
AND METHOD)	
)	

STATEMENT CLAIMING SMALL ENTITY STATUS
37 C.F.R §1.9(f) AND §1.27(c) - SMALL BUSINESS CONCERN

I hereby declare that I am:

- ☐ The owner of the small business concern identified below.
- ☒ An official of the small business concern empowered to act on behalf of the concern identified below.

Name: FastTrack Systems, Inc.

Address: 2955 Campus Drive, Suite 350, San Mateo, CA 94403

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 C.F.R. §121.12, and reproduced in 37 C.F.R. §1.9(d), for purposes of paying reduced fees under Section 41(a) and (b) of Title 35 U.S.C. in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third-party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified below with regard to the invention identified by the above TITLE and INVENTOR(S), and described in:

- ☒ the Specification filed herewith
- ☐ the Application having the above SC/Serial No. and Filed date
- ☐ Patent No. _____ issued _____

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as an independent inventor under 37 C.F.R. §1.9(c) or by any concern which would not qualify as a small business concern under 37 C.F.R. §1.9(d) or a nonprofit organization under 37 C.F.R. §1.9(e).

NAME: _____

ADDRESS: _____

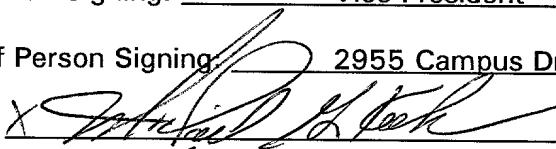
☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small business entity is no longer appropriate. (37 C.F.R. §1.28(b)).

Name of Person Signing: Michael G. Kahn, M.D., Ph.D.

Title of Person Signing: Vice President

Address of Person Signing: 2955 Campus Drive, Suite 350, San Mateo, CA 94403

Signature: 

Date: X 13 May 00

*
Note: Separate statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 C.F.R. §1.27).

Title 37, Code of Federal Regulations, §1.9(c-f)

(c) An **independent inventor** as used in this chapter means any inventor who (1) has not assigned, granted, conveyed, or licensed, and (2) is under no obligation under contract or law to assign, grant, convey, or license, any rights in the invention to any person who could not likewise be classified as an independent inventor if that person had made the invention, or to any concern which would not qualify as a small business concern or a nonprofit organization under this section.

(d) A **small business concern** as used in this chapter means any business concern meeting the size standards set forth in 13 C.F.R. Part 121 to be eligible for reduced patent fees. Questions related to size standards for a small business concern may be directed to: Small Business Administration, Size Standards Staff, 409 Third Street, SW, Washington, DC 2041.

(e) A **nonprofit organization** as used in this chapter means (1) a university or other institution of higher education located in any country; (2) an organization of the type described in section 501(c)(3) of the Internal Revenue Code of 1954 (26 U.S.C. 501(c)(3)) and exempt from taxation under section 501(a) of the Internal Revenue Code (26 U.S.C. 501(a)); (3) any nonprofit scientific or educational organization qualified under a nonprofit organization statute of a state of this country (35 U.S.C. 201(i)); or (4) any nonprofit organization located in a foreign country which would qualify as a nonprofit organization under paragraphs (e) (2) or (3) of this section if it were located in this country.

(f) A **small entity** as used in this chapter means an **independent inventor**, a **small business concern** or a **nonprofit organization** eligible for reduced patent fees.

Title 13, Code of Federal Regulations, §121.12

121.12 Small business for paying reduced patent fees. (a) Pursuant to Pub. L. 97-247, a small business concern for purposes of paying reduced fees under 35 U.S. Code 41 (a) and (b) to the Patent and Trademark Office means any business concern (1) whose number of employees, including those of its affiliates, does not exceed 500 persons and (2) which has not assigned, granted, conveyed, or licensed, and is under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor if that person had made the invention, or to any concern which would not qualify as a small business concern or a nonprofit organization under this section. For the purpose of this section concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both. The number of employees of the business concern is the average over the fiscal year of the persons employed during each of the pay periods of the fiscal year. Employees are those persons employed on a full-time, part-time or temporary basis during the previous fiscal year of the concern.

CLINICAL TRIALS MANAGEMENT SYSTEM AND METHOD

Inventors:

Michael G. Kahn, M.D., Ph.D.

Michael Mischke-Reeds

Exp. Mail No.: *EL553343329US*

Attorney Docket No.: FAST-01000US0 WSW
/wsw/fast/1000.app

CLINICAL TRIALS MANAGEMENT SYSTEM AND METHOD

Inventors:

Michael G. Kahn, M.D., Ph.D.

Michael Mischke-Reeds

BACKGROUND

1. Field of the Invention

The invention relates to the field of medical informatics, and more particularly to a system and method using medical informatics primarily to plan, conduct and analyze clinical trials and their results.

2. Description of Related Art

Over the past number of years, the pharmaceutical industry has enjoyed great economic success. The future, however, looks more challenging. During the next few years, products representing a large percentage of gross revenues will come off patent, increasing the industry's dependence upon new drugs. But even with new drugs, with different companies using the same development tools and pursuing similar targets, first-in-category market exclusivity has also fallen dramatically. Thus in order to compete effectively in the future, the pharmaceutical industry needs to increase throughput in clinical development substantially. And this must be done much faster than it has in the past - time to market is often the most important factor driving pharmaceutical profitability.

A. **Clinical Trials: the Now and Future Bottleneck**

In U.S. pharmaceutical companies alone, a huge percentage of total annual pharmaceutical research and development funds is spent on human clinical trials. Spending on clinical trials is growing at approximately 15% per year, almost 50% above the industry's sales growth rate. Trials are growing both in number and complexity. For example, the average new

drug submission to the U.S. Food & Drug Administration (FDA) now contains more than double the number of clinical trials, more than triple the number of patients, and a more than a 50% increase in the number of procedures per trial, since the early 1980s.

An analysis of the new drug development process shows a major change in the drivers of time and cost. The discovery process, which formerly dominated time to market, has undergone a revolution due to techniques such as combinatorial chemistry and high-throughput screening. The regulatory phase has been reduced due to FDA reforms and European Union harmonization. In their place, human clinical trials have become the main bottleneck. The time required for clinical trials now approaches 50% of the 15 years or so required for the average new drug to come to market.

B. The Trial Process Today

The conduct of clinical trials has changed remarkably little since trials were first performed in the 1940's. Clinical research remains largely a manual, labor-intensive, paper based process reliant on a cottage industry of physicians in office practices and academic medical centers.

1. Initiation

A typical clinical trial begins with the construction of a clinical protocol, a document which describes how a trial is to be performed, what data elements are to be collected, and what medical conditions need to be reported immediately to the pharmaceutical sponsor and the FDA. The clinical protocol and its author are the ultimate authority on every aspect of the conduct of the clinical trial. This document is the basis for every action performed by multiple players in diverse locations during the entire conduct of the trial. Any deviations from the protocol specifications, no matter how well intentioned, threaten the viability of the data and its usefulness for an FDA submission.

The clinical protocol generally starts with a cut-and-paste word-processor approach by a medical director who rarely has developed more than 1-2 drugs from first clinical trial to final regulatory approval and who cannot reference any historical trials database from within his or her own company - let alone across companies. In addition, this physician typically does not have reliable data about how the inclusion or exclusion criteria, the clinical parameters that determine whether a given individual may participate in a clinical trial, will affect the number of patients eligible for the study.

A pharmaceutical research staff member typically translates portions of the trial protocol into a Case Report Form (CRF) manually using word-processor technology and personal experience with a limited number of previous trials. The combined cutting and pasting in both protocol and CRF development often results in redundant items or even irrelevant items being carried over from trial to trial. Data managers typically design and build database structures manually to capture the expected results. When the protocol is amended due to changes in FDA regulations, low accrual rates, or changing practices, as often occurs several times over the multiple years of a big trial, all of these steps are typically repeated manually.

At the trial site, which is often a physician's office, each step of the process from screening patients to matching the protocol criteria, through administering the required diagnostics and therapeutics, to collecting the data both internally and from outside labs, is usually done manually by individuals with another primary job (doctors and nurses seeing 'routine patients') and using paper based systems. The result is that patients who are eligible for a trial often are not recruited or enrolled, errors in following the trial protocol occur, and patient data are often either not captured at all, or are incorrectly transcribed to the CRF from hand written medical records, and are illegible. An extremely large percentage of the cost of a trial is consumed with data audit tasks such as resolving missing data, reconciling inconsistent data, data entry and validation. All of these tasks must be completed before the database can be "locked," statistical analysis can be performed and submission reports can be created.

2. Implementation

Once the trial is underway, data begins flowing back from multiple sites typically on paper forms. These forms routinely contain errors in copying data from source documents to CRFs.

5 Even without transcription errors, the current model of retrospective data collection is severely flawed. It requires busy investigators conducting multiple trials to correctly remember and apply the detailed rules of every protocol. By the time a clinical coordinator fills out the case report form the patient is usually gone, meaning that any data that was not collected or treatment protocol complexities that were not followed are generally unrecoverable. This occurs whether the case report form is paper-based or electronic. The only solution to this problem is point-of-care data capture, which historically has been impractical due to technology limitations.

10 Once the protocol is in place it often has to be amended. Reasons for changing the protocol include new FDA guidelines, amended dosing rules, and eligibility criteria that are found to be so restrictive that it is not possible to enroll enough patients in the trial. These "accrual delays" are among the most costly and time-consuming problems in clinical trials.

15 The protocol amendment process is extremely labor intensive. Further, since protocol amendments are implemented at different sites at different times, sponsors often don't know which protocol is running where. This leads to additional 'noise' in the resulting data and downstream audit problems. In the worst case, patients responding to an experimental drug may not be counted as responders due to protocol violations, but even count against the response rate under an intent-to-treat analysis. It is even conceivable that this purely statistical requirement could cause an otherwise useful drug to fail its trials.

20 Sponsors, or Contract Research Organizations (CROs) working on behalf of sponsors, send out armies of auditors to check the paper CRFs against the paper source documents. Many of the errors they find are simple transcription errors in manually copying data from one paper to the other. Other errors, such as missing data or protocol violations, are more serious and often unrecoverable.

3. Monitoring

The monitoring and audit functions are one of the most dysfunctional parts of the trial process. They consume huge amounts of labor costs, disrupt operations at trial sites, contribute to high turnover, and often involve locking the door after the horse has bolted.

4. Reporting

As information flows back from sites, the mountain of paper grows. The typical New Drug Application (NDA) literally fills a semi-truck with paper. The major advance in the past few years has the addition of electronic filing, but this is basically a series of electronic page copies of the same paper documents - it does not necessarily provide quantitative data tables or other tools to automate analysis.

B. The Costs of Inefficiency

It can be seen that this complex manual process is highly inefficient and slow. And since each trial is largely a custom enterprise, the same thing happens all over again with the next trial. Turnover in the trials industry is also high, so valuable experience from trial to trial and drug to drug is often lost.

The net result of this complex, manual process is that despite accumulated experience, it is costing more to conduct each successive trial.

In addition to being slow and expensive, the current clinical trial process often hurts the market value of the resulting drug in two important ways. First, the FDA reviews drugs on an "intent to treat" basis. That means that every patient enrolled in a trial is included in the denominator (positive responders/total treated) when calculating a drug's efficacy. However, only patients who respond to treatment and comply with the protocol are included in the numerator as positive responders. Not infrequently, a patient responds to a drug favorably, but is actually counted as a failure due to significant protocol non-compliance. In rare cases, an entire

trial site is disqualified due to non-compliance. Non-compliance is often a result of preventable errors in patient management.

The second major way that the current clinical trial process hurts drug market value is that much of the fine grain detail about the drug and how it is used is not captured and passed from clinical development to marketing within a pharmaceutical company. As a result, virtually every pharmaceutical company has a second medical department that is a part of the marketing group. This group often repeats studies similar to those used for regulatory approval in order to capture the information necessary to market the drug effectively.

C. The Situation at Trial Sites

Despite the existence of a large number of clinical trials that are actively recruiting patients, only a tiny percentage of eligible patients are enrolled any clinical trial. Physicians, too, seem reluctant to engage in clinical trials. One study by the American Society of Clinical Oncology found that barriers to increased enrollment included restrictive eligibility criteria, large amount of required paperwork, insufficient support staff, and lack of sufficient time for clinical research.

Clinical trials consist of a complex sequence of steps. On average, a clinical trial requires more than 10 sites, enrolls more than 10 patients per site and contains more than 50 pages for each patient's case report form (data entry sheet). Given this complexity, delays are a frequent occurrence. A delay in any one step, especially in early steps such as patient accrual, propagates and magnifies that delay downstream in the sequence.

A significant barrier to accurate accrual planning is the difficulty trial site investigators have in predicting their rate of enrollment until after a trial has begun. Even experienced investigators tend to overestimate the total number of enrolled patients they could obtain by the end of the study. Novice investigators tend to overestimate recruitment potential by a larger margin than do experienced investigators, and with the rapid increase in the number of

investigators participating in clinical trials, the vast majority of current investigators have not had significant experience in clinical trials.

D. Absence of Information Infrastructure

Given the above state of affairs, one might expect that the clinical trials industry would be ripe for automation. But despite the desperate need for automation, remarkably little has been done.

While the pharmaceutical industry spends hundreds of millions of dollars annually on clinical information systems, most of this investment is in internal custom databases and systems within the pharmaceutical company; very little of this technology investment is at the physician office level. Each trial, even when conducted by the same company or when testing the same drug, is usually a custom collection of sites, procedures and protocols. More than half of trials are conducted for the pharmaceutical industry by Contract Research Organizations (CROs) using the same manual systems and custom physician networks.

The clinical trials information technology environment contributes to this situation. Clinical trials are information-intensive processes - in fact, information is their only product. Despite this, there is no comprehensive information management solution available. Instead there are many vendors, each providing tools that address different pieces of the problem. Many of these are good products that have a role to play, but they do not provide a way of integrating or managing information across the trial process.

The presently available automation tools include those that fall into the following major categories:

- Clinical data capture (CDC)
- Site-oriented trial management
- Electronic Medical Records (EMRs) with Trial-Support Features
- Trial Protocol design tools

- Site-sponsor matching services
- Clinical data management

5

Clinical Research Organizations (CROs) and Site Management Organizations (SMOs) also provide some information services to trial sites and sponsors.

1. Clinical Data Capture (CDC) Products

10

These products are targeted at trial sites, aiming to improve speed and accuracy of data entry. Most are rapidly moving to Web-based architectures. Some offer off-line data entry, meaning that data can be captured while the computer is disconnected from the Internet. Most companies can point to half a dozen pilot sites and almost no paying customers.

15

These products do not create an overall, start-to-finish, clinical trials management framework. These products also see "trial design" merely as "CRF design," ignoring a host of services and value that can be provided by a comprehensive clinical trials system. They also fail to make any significant advance over conventional methods of treating each trial as a "one-off" activity. For example, the companies offering CDC products continue to custom-design each CRF for each trial, doing not much more than substituting HTML code for printed or word-processor forms.

20

2. Site-Oriented Trial Management

25

These products are targeted at trial sites and trial sponsors, aiming to improve trial execution through scheduling, financial management, accrual, visit tracking. These products do not provide electronic clinical data entry, nor do they assist in protocol design, trial planning for sponsors, patient accrual or task management.

3. Electronic Medical Records (EMR) with Trial-Support Features

These products aim to support patient management of all patients, not just study patients, replacing most or all of a paper charting system. Some EMR vendors are focusing on particular disease areas, with KnowMed being a notable example in oncology.

These products for the most part do not focus specifically on the features needed to support clinical trials. They also require major behavior changes affecting every provider in a clinical setting, as well as requiring substantial capital investments in hardware and software. Perhaps because of these large hurdles, EMR adoption has been very slow.

4. Trial Protocol Design Tools

These products are targeted at trial sponsors, aiming to improve the protocol design and program design processes using modeling and simulation technologies. One vendor in this segment, PharSight, is known for its use of PK/PD (pharmacokinetic/pharmacodynamic) modeling tools and is extending its products and services to support trial protocol design more broadly.

None of the companies offering trial protocol design tools provide the host of services and value that can be provided by a comprehensive clinical trials system.

5. Trial Matching Services

Some recent Web-based services aim to match sponsors and sites, based on a database of trials by sponsor and of sites' patient demographics. A related approach is to identify trials that a specific patient may be eligible for, based on matching patient characteristics against a database of eligibility criteria for active trials. This latter functionality is often embedded in a disease-specific healthcare portal such as cancerfacts.com.

6. Clinical Data Management

Two well-established products, Domain ClinTrial and Oracle Clinical, support the back-end database functionality needed by sponsors to store the trial data coming in from CRFs.

These products provide a visit-specific way of storing and querying study data. The protocol sponsor can design a template for the storage of such data in accordance with the protocol's visit schema, but these templates are custom-designed for each protocol. These products do not provide protocol authoring or patient management assistance.

7. Statistical Analysis

The SAS Institute (SAS) has defined the standard format for statistical analysis and FDA reporting. This is merely a data format, and does not otherwise assist in the design or execution of clinical trial protocols.

8. Site Management Organizations (SMOs)

SMOs maintain a network of clinical trial sites and provide a common Institutional Review Board (IRB) and centralized contracting/invoicing. SMOs have not been making significant technology investments, and in any event, do not offer trial design services to sponsors.

9. Clinical Research Organizations (CROs)

CROs provide, among other services, trial protocol design and execution services. But they do so on substantially the same model as do sponsors: labor-intensive, paper-based, slow, and expensive. CROs have made only limited investments in information technology.

E. The Need for a Comprehensive Clinical Trials System

It can be seen that the current information model for clinical trials is highly fragmented. This has led to high costs, "noisy" data, and long trial times. Without a comprehensive, service-oriented information solution it is very hard to get away from the current paradigm of paper, faxes and labor-intensive processes. And it has become clear that simply "throwing more bodies"

at trials will not produce the required results, particularly as trial throughput demands increase. A new, comprehensive model is required.

SUMMARY OF THE INVENTION

5 According to the invention, roughly described, clinical trials are defined, managed and evaluated according to an overall end-to-end system solution which starts with the creation of protocol meta-models by a central authority, and ends with the conduct of trials by clinical sites, who then report back electronically for near-real-time monitoring by study sponsors and for analysis by the central authority. The central authority first creates protocol meta-models, one
10 for each of several different disease categories, and makes them available to protocol designers. Each meta-model includes a short list of preliminary patient eligibility attributes which are appropriate for a particular disease category. The protocol designer chooses the meta-model and preliminary eligibility list appropriate for the relevant disease category, and encodes the clinical trial protocol, including eligibility and patient workflow, within the selected meta-model. The
15 resulting protocol database is stored together with databases of other protocols in the same and different disease categories, in a library of protocol databases maintained by the central authority. Sponsors and individual clinical sites have access to only the particular protocols for which they are authorized.

Study sites optionally use a two-stage screening procedure in order to identify clinical
20 studies for which individual patients are eligible, and patients who are eligible for individual clinical studies. The study sites make reference to the protocol databases to which they have access in the protocol database library in order to make these determinations. In one embodiment the data that is gleaned from patients being screened is retained in a patient-specific database of patient attributes, or in other embodiments the data can be stored anonymously or discarded after
25 screening. Once a patient is enrolled into a study, the protocol database indicates to the clinician exactly what tasks are to be performed at each patient visit. These tasks can include both patient management tasks, such as administering a drug or taking a measurement, and also data

management tasks, such as completing and submitting a particular CRF. The workflow graph embedded in the protocol database advantageously also instructs the proper time for the clinician to obtain informed consent from a patient during the eligibility screening process, and when to perform future tasks, such as the acceptable date range for the next patient visit.

5 The system keeps track of the progress of the patient and the clinician through the workflow graph of a particular protocol. The system reports this information to study sponsors, who can then monitor the progress of an overall clinical trial in near-real-time, and to the central authority which can then generate performance metrics. Advantageously, a common controlled medical terminology database is used by all components of the system in order to ensure
10 consistent usage of medical terminology by all the participants. The protocol database is advantageously used also to drive other kinds of problem-solving methods, such as an accrual simulation tool and a Find-Me-Patients tool.

BRIEF DESCRIPTION OF THE DRAWINGS

15 The invention will be described with respect to specific embodiments thereof, and reference will be made to the drawings, in which:

Fig. 1 is a symbolic block diagram illustrating significant aspects of a clinical trials management system and method incorporating features of the invention.

20 Figs. 2-8 are screen shots of an example for an Intelligent Clinical Protocol (iCP) database.

Fig. 9 is a flow chart detail of the step of creating iCPs in Fig. 1.

Fig. 10 is a flow chart of an optional method for a protocol author to establish patient eligibility criteria.

25 Figs. 11-25 are screen shots of screens produced by Protégé 2000, and will help illustrate the relationship between a protocol meta-model and an example individual clinical trial protocol.

Fig. 26 is a flow chart detail of step 122 (Fig. 1).

DETAILED DESCRIPTION

Fig. 1 is a symbolic block diagram illustrating significant aspects of a clinical trials management system and method incorporating features of the invention. In the figure, solid arrows indicate process flow, whereas broken arrows indicate information flow. In broad summary, the system is an end-to-end solution which starts with the creation of protocol meta-models by a central authority, and ends with the conduct of trials by clinical sites, who then report back electronically for near-real-time monitoring by study sponsors, for analysis by the central authority, and for use by study sponsors in identifying promising sites for future studies. As used herein, a "clinical site" can be physically at a single or multiple locations, but conducts clinical trials as a single entity. The term also includes SMOs.

Referring to Fig. 1, the central authority initially creates one or more protocol meta-models (step 110) for use in facilitating the design of clinical trial protocols. Each meta-model can be thought of as a set of building blocks from which particular protocols can be built. Preferably, the central authority creates a different meta-model for each of several disease classifications, with the building block in each meta-model being appropriate to that disease classification. In an embodiment, a meta-model is described in terms of object oriented design. The building blocks are represented as object classes, and an individual protocol database contains instances of the available classes.

The building blocks contained in a meta-model include the different kinds of steps that might be required in a trial protocol workflow, such as, for example, a branching step, an action step, a synchronization step, and so on. The available action steps for a meta-model directed to breast cancer trials might differ from the available action steps in a meta-model directed to prostate cancer trials, for example, by making available only those kinds of steps which might be appropriate for the particular disease category. For example, a step of brachytherapy might be available in the prostate cancer meta-model, but not in the breast cancer meta-model; and a step of mammography might be available in the breast cancer meta-model, but not in the prostate cancer meta-model.

1
2
3
4
5 The meta-models also include lists, again appropriate to the particular disease category,
6 within which a protocol designer can define preliminary criteria for the eligibility of patients for
7 a particular study. These preliminary eligibility criteria lists do not preclude a protocol designer
8 from building further eligibility criteria into any particular clinical trial protocol. As set forth in
9 more detail below, the options available in the lists of preliminary eligibility criteria are
10 intentionally limited in number so as to facilitate the building of a large database of potential
11 patients for studies within the particular disease area. At the same time, however, it is also
12 desirable that the options be numerous or narrow enough in order to provide a good first cut of
13 eligible patients. In order to best satisfy these two competing goals, it is desirable that an expert
14 or a team of experts knowledgeable about the particular disease category of a particular meta-
15 model be heavily involved in the development of the preliminary eligibility criteria lists for the
16 particular meta-model. In addition, because of the difficulty and length of time required to
17 develop a large database of potential patients, it is further desirable that once the eligibility
18 criteria options are established for a particular meta-model, they do not change except as
19 absolutely necessary. Such changes might be mandated as a result of improved understanding
20 of a disease, for example, and are rigorously managed throughout the overall system of Fig. 1.

21 Table I sets forth example Preliminary Eligibility Criteria lists for five disease categories,
22 specifically breast cancer, small cell lung cancer, non-small cell lung cancer, colorectal cancer and
23 prostate cancer. As can be seen, each list includes a small number of patient attributes, each with
24 a set of available choices from which the protocol designer can choose, in order to encode
25 preliminary eligibility criteria for a particular protocol. The protocol meta-model for breast
26 cancer, for example, includes the list of attributes and the list of available choices for each
27 attribute, as shown in the row of the table for "Breast Cancer."

TABLE I
Example Preliminary Eligibility Criteria Lists

Disease	QS attribute	Choices
Breast cancer	Current Stage	0, I, II (IIA, IIB), III (IIIA, IIIB), IV
	Prior Chemo	None, Neoadj/Adj, Tx Adv Disease
	Prior RT	None, Primary tumor, Metastatic Dz
	Prior Surgery	Y,N
	Prior Hormonal	None, Neoadj/Adj, Tx Adv Disease
Lung cancer, small cell	Current Stage	Limited, Extensive
	Prior Chemo	None, Neoadj/Adj, Tx Adv Disease
	Prior RT	None, Primary tumor, Metastatic Dz
	Prior Surgery	Y,N
Lung cancer, non-small cell	Current Stage	0, I (IA, IB), II (IIA, IIB), IIIA, IIIB, IV
	Prior Chemo	None, Neoadj/Adj, Tx Adv Disease
	Prior RT	None, Primary tumor, Metastatic Dz
	Prior Surgery	Y,N
Colorectal cancer	Current Stage	0, I, II, III, IV
	Prior Chemo	None, Neoadj/Adj, Tx Adv Disease
	Prior RT	None, Primary tumor, Metastatic Dz
	Prior Surgery	Y,N
Prostate cancer	Metastases	Y,N
	Primary Tumor	N/A, T0, T1a, T1b, T1c, T2 (T2a, T2b), T3 (T3a, T3b), T4
	Nodes	N/A, N0, N1
	Prior Chemo	None, Neoadj/Adj, Tx Adv Disease
	Prior RT	None, Primary tumor, Metastatic Dz
	Prior Surgery	Y,N
	Prior Hormonal	None, Neoadj/Adj, Tx Adv Disease

In the embodiment illustrated by Table I, the designer encodes preliminary eligibility criteria by assigning one of the available choices to each of at least a subset of the attributes in

the selected list. Each "criterion" is defined by an attribute and its assigned value, so that a patient satisfies the criterion only if the patient has the specified value for that attribute. Each criterion is then classified either as an "inclusion" criterion or an "exclusion" criterion; a patient must satisfy all the inclusion criteria and none of the exclusion criteria in order to pass preliminary eligibility.

The logic of the preliminary eligibility criteria is capable of many variations in different embodiments. In one embodiment, for example, the designer is permitted to assign more than one of the available values to a given attribute. In this case, a patient who has any of the assigned values for the given attribute satisfies the criterion. In another embodiment, one or more of the available values for a given attribute can be specified as a numeric range, and the designer can assign any value or sub-range of values within that range to the attribute. In addition, the condition for satisfying the criterion can be specified by the designer to be something other than equality (e.g., "attribute having a value less than N", or "attribute having a value greater than N".) Speaking more generally, each criterion is defined by an attribute and a "condition", and the patient must satisfy the condition with respect to that attribute in order to satisfy the criterion.

Applicants believe that one of the reasons why in the past it has been difficult to create tools which are useful throughout the clinical trials design, execution and analysis processes, as shown in Fig. 1, is that each tool presently available maintains its data in a different format, and because there is no consistency among the different tools regarding such important questions as what is meant by a particular medical term according to which the data is maintained. The problem of consistent medical terminology is one that extends well beyond the field of clinical trials, and has spawned significant academic discourse within the field of medical informatics. As examples, see the entire November 1998 issue of "Methods of Information in Medicine", Vol. 37, No. 4-5, which is incorporated herein by reference in its entirety. See in particular the following articles: "Editorial: the Concepts of Language and the Language of Concepts", by J.J. Cimino (p. 311); "Desiderata for Controlled Medical Vocabularies in the Twenty-First Century", by J.J. Cimino (pp. 394-403); "Concept-Oriented Standardization and Statistics-Oriented

Classification: Continuing the Classification Versus Nomenclature Controversy", by J. Ingenerf and W. Giere (pp. 527-539); and "Standards to Support Development of Terminological Systems for Health Care Telematics", by A. Rossi Mori, F. Consorti and E. Galeazzi (pp. 551-563). See also, Broverman, "Overview of Controlled Clinical Terminologies", slides for CME course, August 18, 1999, incorporated herein by reference.

The work on terminology consistency problems has yielded a number of different databases of medical concepts, terms and attributes, none of which have been intended for use in the field of clinical trial protocols but most of which can provide some benefit in that field. These terminology databases, sometimes referred to herein as "controlled medical terminologies" (CMTs), include interface terminologies intended to support navigation for structured data entry, reference terminologies intended to support aggregation and analysis of medical data, and administrative terminology intended to support reporting and billing requirements. Interface terminologies, which include such terminologies as MEDCIN, Oceania CKB, and Purkinjie, are patient-dependent terminologies, are easily navigable to support workflow, and provide groupings of observations by context. Reference terminologies, which include SNOMED, LOINC, Meddra, and Read, are patient-independent terminologies. They are intended to completely cover a domain of discourse. They include definitions of logical concepts and are organized into hierarchies of semantic classifications. Administrative terminologies, which include ICD-9 and CPT-4, are also patient-independent. They are designed primarily for reporting and billing requirements and do not contain formal definitions. They are organized hierarchically, but only to a limited extent. In addition to the classification of CMTs as interface terminologies, reference terminologies or administrative terminologies, some of the existing CMTs (such as SNOMED) are better at covering medical diagnoses than others, and others (such as CPT-4) are better at covering the domain of medical procedures. Meddra is better at covering the field of adverse events reporting, having been developed by the Food and Drug Administration primarily for post-market surveillance of drug usage experience. All of the above-mentioned CMTs are incorporated by reference herein.

The overall clinical trials process illustrated in Fig. 1 is performed by a wide variety of different people, all of whom might have different understandings about the meaning of various concepts, terms and attributes. Therefore, in order for all the different steps and tools to work well together, the system of Fig. 1 takes advantage of a CMT 112 wherever possible. For example, most if not all of the concepts, terms and attributes which are used in the workflow task building blocks and patient eligibility criteria options made available in the meta-models produced in step 110, are entries in the CMT 112. In one embodiment, a meta-model contains copies of the relevant entries from the CMT 112, whereas in another embodiment, the meta-models contain merely pointers to the relevant entries in CMT 112. A meta-model designer or protocol author preferably uses a CMT browser to select desired CMT entries for inclusion in a meta-model or protocol.

The CMT 112 can be any of the CMTs presently existing, or can be a new CMT altogether. Preferably, CMT 112 includes entries developed from several of the different presently existing CMTs, as well as additional entries which are appropriate for clinical trial protocols, and for the particular disease categories covered by the various meta-models produced in step 110. Preferably CMT 112 is organized hierarchically by concept. Each concept includes pointers to one or more terms which describe the concept synonymously. For example, the concept "hypertension" might have pointers to the terms "hypertension", "elevated blood pressure", and "high blood pressure". Each concept also includes pointers to one or more attributes. The "hypertension" concept, for example, might include a pointer to an attribute, "diastolic blood pressure greater than 95mm Hg," where "blood pressure" is itself a concept and is represented by a pointer back to the list of concepts.

The step 110 of creating protocol meta-models is performed using a meta-model authoring tool. Protégé 2000 is an example of a tool that can be used as a meta-model authoring tool. Protégé 2000 is described in a number of publications including William E. Grosso, et. al., "Knowledge Modeling at the Millennium (The Design and Evolution of Protégé-2000)," SMI Report Number: SMI-1999-0801 (1999), available at <http://smi-web.stanford.edu/>

pubs/SMI_Abstracts/SMI-1999-0801.html, visited 01/01/2000, incorporated by reference herein. In brief summary, Protégé 2000 is a tool that helps users build other tools that are custom-tailored to assist with knowledge-acquisition for expert systems in specific application areas. It allows a user to define "generic ontologies" for different categories of endeavor, and then to
5 define "domain-specific ontologies" for the application of the generic ontology to more specific situations. In many ways, Protégé 2000 assumes that the different generic ontologies differ from each other by major categories of medical endeavors (such as medical diagnosis versus clinical trials), and the domain-specific ontologies differ from each other by disease category. In the present embodiment, however, all ontologies are within the category of medical endeavor known
10 as clinical trials and protocols. The different generic ontologies correspond to the different meta-models produced in step 110 (Fig. 1), which differ from each other by disease category. In this sense, the generic ontologies produced by Protégé in step 110 are directed to a much more specific domain than those produced in other applications of Protégé 2000.

Since the meta-models produced in step 110 include numerous building blocks as well
15 as many options for patient eligibility criteria, a wide variety of different kinds of clinical trial protocols, both simple and complex, can be designed. These meta-models are provided to clinical trial protocol designers who use them, preferably again with the assistance of Protégé 2000, to design individual clinical trial protocols in step 114.

In step 114 of Fig. 1, a protocol designer desiring to design a protocol for a clinical trial
20 in a particular disease category, first selects the appropriate meta-model and then uses the authoring tool to design and memorialize the protocol. As in step 110, one embodiment of the authoring tool for step 114 is based on Protégé 2000. The output of step 114 is a database which contains all the significant required elements of a protocol. This database is sometimes referred to herein as an Intelligent Clinical Protocol (iCP) database, and provides the underlying logical
25 structure for driving much of the processes that take place in the remainder of Fig. 1.

Conceptually, an iCP database is a computerized data structure that encodes most significant aspects of a clinical protocol, including eligibility criteria, randomization options,

treatment sequences, data requirements, and protocol modifications based on patient outcomes or complications. The iCP structure can be readily extended to encompass new concepts, new drugs, and new testing procedures as required by new drugs and protocols. The iCP database is used by most software modules in the overall system to ensure that all protocol parameters, treatment decisions, and testing procedures are followed.

The iCP database can be thought of as being similar to the CAD/CAM tools used in manufacturing. For example, a CAD/CAM model of an airplane contains objects which represent various components of an airplane, such as engines, wings, and fuselage. Each component has a number of additional attributes specific to that component - engines have thrust and fuel consumption; wings have lift and weight. By constructing a comprehensive model of an airplane, numerous different types of simulations can be executed using the same model to ensure consistent results, such as flight characteristics, passenger/revenue projections, maintenance schedules. And finally, the completed CAD/CAM simulations automatically produced drawings and manufacturing specifications to accelerate actual production. While an iCP database differs from the CAD/CAM model in important ways, it too provides a comprehensive model of a clinical protocol so as to support consistent tools created for problems such as accrual, patient screening and workflow management. By using a comprehensive model and a unifying standard vocabulary, all tools behave according to the protocol specifications.

As used herein, the term "database" does not necessarily imply any unity of structure. For example, two or more separate databases, when considered together, still constitute a "database" as that term is used herein.

As described in more detail below, the iCP data structures can be used by multiple tools to ensure that the tool performs in strict compliance with the clinical protocol requirements. For example, a patient recruitment simulation tool can use the eligibility criteria encoded into an iCP data structure, and a workflow management tool uses the visit-specific task guidelines and data capture requirements encoded into the iCP data structure. The behavior of all such tools will be consistent with the protocol because they all use the same iCP database.

Many clinical systems provide a "dumb database" for patient data, but offer no intelligence, no automation. While these systems may offer some efficiency benefits compared to paper systems, they are incapable of driving workflow management, sophisticated data validation or recognizing protocol-critical patterns in patient data (e.g. a toxic response to a drug that should trigger a modification to the treatment). A few systems have used rule-based expert systems or other technologies to deliver more intelligence to clinicians, but these have encountered significant problems: huge up-front modeling costs and ongoing maintenance costs; unpredictable system behavior over time; and an inability to reuse knowledge content or software components. So the choices available for clinical investigators have been poor: use paper, use an electronic file cabinet with no intelligence, or build a custom intelligent system for each trial. The use of an iCP database and a variety of tools designed to be driven by an iCP database overcomes many of the deficiencies with the prior art options.

The iCP database is used to drive all downstream "problem solvers" such as electronic case report forms, and assures that those applications are revised automatically as the protocol changes. This assures protocol compliance. The iCP authoring tool draws on external knowledge bases to help trial designers, and creates a library of re-usable protocol "modules" that can be incorporated in new trials, saving time and cost and enabling a clinical trial protocol design process that is more akin to customization than to the current "every trial unique" model.

Figs. 11-25 are screen shots of screens produced by Protégé 2000, and will help illustrate the relationship between a protocol meta-model and an example individual clinical trial protocol. Fig. 11 is a screen shot illustrating the overall class structure in the left-hand pane 1110. Of particular interest to the present discussion is the class 1112, called "FastTrackClass" and the classes under class 1112. FastTrackClass 1112 and those below it represent an example of a protocol meta-model. This particular meta-model is not specific to a single disease category, but one that is specific to a single disease category is described below with respect to Figs. 2-8.

The right-hand pane 1114 of the screen shot of Fig. 11 sets forth the various slots that have been established for a selected one of the classes in the left-hand pane 1110. In the image

of Fig. 11, the "protocol" class 1116, a subclass of FastTrackClass 1112, has been selected (as indicated by the shading). In the right-hand pane 1114, specifically in the window 1118, the individual slots for protocol class 1116 are shown. Only those indicated by a shaded "S" are pertinent to the present discussion; those indicated by an unshaded "S" are more general and not important for an understanding of the invention. It can be seen that several of the slots in the window 1118 contain "facets" which, for some slots, define a limited set of "values" that can be stored in the particular slot. For example, the slot "quickScreenCriterion" can take on only the specific values "prostate cancer," "colorectal cancer," "breast cancer," etc. These are the only disease categories for which quickScreenCriteria had been established at the time the screen shot of Fig. 11 was taken.

Fig. 12 is a screen shot of a particular instance of class "protocol" in Fig. 11, specifically a protocol object having identifier CALGB 9840. It can be seen that each of the slots defined for protocol class 1116 has been filled in with specific values in the protocol class object instance of Fig. 12. Whereas Fig. 11 illustrates an aspect of a clinical trial protocol meta-model, Fig. 12 illustrates the top-level object of an actual iCP designated CALGB 9840. Of particular note, it can be seen that for the iCP CALGB 9840, the slot "quickScreenCriterion" 1120 (Fig. 11) has been filled in by the protocol author as "Breast Cancer" (item 1210 in Fig. 12), which is one of the available values 1122 for the quickScreenCriterion slot 1120 in Fig. 11. In addition, the protocol author has also filled in "CALGB 9840 Eligibility Criteria", an instance of EligibilityCriteriaSet class 1124, for an EligibilityCriteriaSet slot (not shown in Fig. 11) of the protocol class object. Essentially, therefore, the protocol class object of Fig. 12 includes a pointer to another object identifying the "further eligibility criteria" for iCP CALGB 9840.

Fig. 13 illustrates in the right-hand pane 1310 the slots defined in the protocol meta-model for the class "EligibilityCriteriaSet" 1124. Of particular note is that an EligibilityCriteriaSet object will include both exclusion criteria (slot 1312) and inclusion criteria (slot 1314). It can be seen from Fig. 13 that the values that can be placed in slots 1312 and 1314 are objects of the class "EligibilityCriterion" 1126. It will be appreciated that in a different

embodiment, other structural organizations for maintaining the same information are possible, such as a single list including all patient eligibility criteria, and flags indicating whether each criterion is an inclusion criterion or an exclusion criterion.

Fig. 14 illustrates in the right-hand pane 1410 the slots which can be filled in for objects of the class "EligibilityCriterion". As can be seen, these slots are merely for descriptive text strings, primarily a slot 1412 for a long description and a slot 1414 for a short description.

Fig. 15 illustrates the instance of the EligibilityCriteriaSet class which appears in the CALGB 9840 iCP. It can be seen that the object contains a list of inclusion criteria and a list of exclusion criteria, each criterion of which is an instance of the EligibilityCriterion class 1126. One of such instances 1510 is illustrated in Fig. 16. Only the short description 1610 and the long description 1612 have been entered by the protocol author.

An iCP, in addition to containing a pointer (1210 in Fig. 12) to the relevant set of quickScreenCriteria, and also identifying (1212) further eligibility criteria, also contains the protocol workflow in the form of patient visits, management tasks to take place during a visit, and transitions from one visit to another. The right-hand pane 1710 of Fig. 17 illustrates the slots available for an object instance of the class "visit" 1128. It can be seen that in addition to a slot 1712 for possible visit transitions, the Visit class also includes a slot 1714 for patient management tasks as well as another slot 1716 for data management tasks. In other words, a clinical trial protocol prepared using this clinical trial protocol meta-model can include instructions to clinical personnel not only for patient management tasks (such as administer certain medication or take certain tests), but also data management tasks (such as to complete certain CRFs).

Fig. 18 illustrates a particular instance of visit class 1128, which is included in the CALGB 9840 iCP. As can be seen, it includes a window 1810 containing the possible visit transitions, a window 1812 containing the patient management tasks, and a window 1816 showing the data management tasks for a particular visit referred to as "Arm A treatment visit". The data management tasks and patient management tasks are all instance of the

"ManagementTask" class 1130 (Fig. 11), the slots of which are set forth in the right-hand pane 1910 of Fig. 19. As with the EligibilityCriterion class 1126 (Fig. 14), the slots available to a protocol author in a ManagementTask object are mostly text fields.

Fig. 20 illustrates the ManagementTask object 1816 (Fig. 18), "Give Arm A Paclataxel
5 Treatment." Similarly, Fig. 21 illustrates the ManagementTask object 1818, "Submit Form C-116". The kinds of data management tasks which can be included in an iCP according to the clinical trial protocol meta-model include, for example, tasks calling for clinical personnel to submit a particular form, and a task calling for clinical personnel to obtain informed consent.

Returning to Fig. 17, the values that a protocol author places in the slot 1712 of a visit
10 class 1128 object are themselves instances of VisitToVisitTransition class 2210 (Fig. 22) in the meta-model. The right-hand pane 2212 shows the slots which are available in an object of the VisitToVisitTransition class 2210. As can be seen, it includes a slot 2214 which points to the first visit object of the transition, another slot 2216 which points to a second visit object of the transition, and three slots 2218, 2220 and 2222 in which the protocol author provides the minimum, maximum and preferred relative time of the transition. Fig. 23 shows the contents of
15 a VisitToVisitTransition object 1818 (Fig. 18) in the CALGB 9840 iCP.

In addition to being kept in the form of Visit objects, management task objects and VisitToVisitTransition objects, the protocol meta-model also allows an iCP to keep the protocol schema in a graphical or diagrammatic form as well. In fact, it is the graphical form that protocol
20 authors typically use, with intuitive drag-and-drop and drill-down behaviors, to encode clinical trial protocols using Protégé 2000. In the protocol meta-model, a slot 1134 is provided in the Protocol object class 1116 for pointing to an object of the ProtocolSchemaDiagram class 1132 (Fig. 11). Fig. 24 shows the slots available for ProtocolSchemaDiagram class 1132. As can be seen, they include a slot 2410 for diagrammatic connectors, and another slot 2412 for diagram
25 nodes. The diagram connectors are merely the VisitToVisitTransition objects described previously, and the diagram nodes are merely the Visit objects described previously. Fig. 25 illustrates the ProtocolSchemaDiagram object 1214 (Fig. 12) in the CALGB 9840 iCP. It can

be seen that the entire clinical trial protocol schema is illustrated graphically in pane 2510, and the available components of the graph (connector objects 2512 and visit objects 2514) are available in pane 1516 for dragging to desired locations on the graph.

Figs. 2-8 are screen shots of another example iCP database, created and displayed by Protégé 2000 as an authoring tool. This iCP encodes clinical trial protocol labeled CALGB 49802, and differs from the CALGB 9840 iCP in that CALGB 49802 was encoded using a starting meta-model that was already specific to a specific disease area, namely cancer. It will be appreciated that in other embodiments, the meta-models can be even more disease specific, for example meta-models directed specifically to breast cancer, prostate cancer and so on.

Fig. 2 is a screen shot of the top level of the CALGB 49802 iCP database. The screen shot sets forth all of the text fields of the protocol, as well as a list 210 of patient inclusion criteria and a list 212 of patient exclusion criteria.

Fig. 3 is a screen shot of the Management_Diagram class object for the iCP, illustrating the workflow diagram for the clinical trial protocol of Fig. 2. The workflow diagram sets forth the clinical algorithm, that is, the sequence of steps, decisions and actions that the protocol specification requires to take place during the course of treating a patient under the particular protocol. The algorithm is maintained as sets of tasks organized as a graph 310, illustrated in the left-hand pane of the screen shot of Fig. 3. The protocol author adds steps and/or decision objects to the graph by selecting the desired type of object from the palate 312 in the right-hand pane of the screen shot of Fig. 3, and instantiating them at the desired position in the graph 310. Buried beneath each object in the graph 310 are fields which the protocol designer completes in order to provide the required details about each step, decision or action. The user interface of the authoring tool allows the designer to drill down below each object in the graph 310 by double-clicking on the desired object. The Management_Diagram object for the iCP also specifies a First Step (field 344), pointing to Consent & Enroll step 314, and a Last Step (field 346), which is blank.

Referring to the graph 310, it can be seen that the workflow diagram begins with a "Consent & Enroll" object 314. This step, which is described in more detail below, includes sub-steps of obtaining patient informed consent, evaluating the patient's medical information against the eligibility criteria for the subject clinical trial protocol, and if all such criteria are satisfied, enrolling the patient in the trial.

After consent and enrollment, step 316 is a randomization step. If the patient is assigned to Arm 1 of the protocol (step 318), then workflow continues with the "Begin CALGB 49802 Arm 1" step object 320. In this Arm, in step 322, procedures are performed according Arm 1 of the study, and workflow continues with the "Completed Therapy" step 324. If in step 318 the patient was assigned Arm 2, then workflow continues at the "Begin CALGB 49802 Arm 2" step 326. Workflow then continues with step 328, in which the procedures of protocol Arm 2 are performed and, when done, workflow continues at the "Completed Therapy" scenario step 324.

After step 324, workflow for all patients proceeds to condition_step "ER+ or PR+" step 330. If a patient is neither estrogen-receptor positive nor progesterone receptor positive, then the patient proceeds to a "CALGB 49802 long-term follow-up" sub-guideline object step 332. If a patient is either estrogen-receptor positive or progesterone receptor positive, then the patient instead proceeds to a "Post-menopausal?" condition_step object 334. If the patient is post-menopausal, then the patient proceeds to a "Begin Tamoxifen" step 336, and thereafter to the long-term follow-up sub-guideline 332.

If in step 334, the patient is not post-menopausal, then workflow proceeds to a "Consider Tamoxifen" choice_step object 338. In this step, the physician using clinical judgment determines whether the patient should be given Tamoxifen. If so (choice object 340), then the patient continues to the "Begin Tamoxifen" step object 336. If not (choice object 342), then workflow proceeds directly to the long-term follow-up sub-guideline object 332. It will be appreciated that the graph 310 is only one example of a graph that can be created in different embodiments to describe the same overall protocol schema. It will also be appreciated that the library of object

classes 312 could be changed to a different library of object classes, while still being oriented to protocol-directed clinical studies.

Fig. 4 is a screen shot showing the result of "drilling down" on the "Consent & Enroll" step 314 (Fig. 3). As can be seen, Fig. 4 contains a sub-graph (which is also considered herein to be a "graph" in its own right) 410. The Consent & Enroll step 314 also contains certain text fields illustrated in Fig. 4 and not important for an understanding of the invention.

As can be seen, graph 410 begins with a "collect pre-study variables 1" step object 410, in which the clinician is instructed to obtain certain patient medical information that does not require informed consent. Step 412 is an "obtain informed consent" step, which includes a data management task instructing the clinician to present the study informed consent form to the patient and to request the patient's signature. In another embodiment, the step 412 might include a sub-graph which instructs the clinician to present the informed consent form, and if it is not signed and returned immediately, then to schedule follow-up reminder telephone calls at future dates until the patient returns a signed form or declines to participate.

After informed consent is obtained, the sub-graph 410 continues at step object 414, "collect pre-study variable 2". This step instructs the clinician to obtain certain additional patient medical information required for eligibility determination. If the patient is eligible for the study and wishes to participate, then the flow continues at step object 416, "collect stratification variables". The flow then continues at step 418, "obtain registration I.D. and Arm assignment" which effectively enrolls the patient in the trial.

Fig. 5 is a detail of the "Collect Stratification Variables" step 416 (Fig. 4). As can be seen, it contains a number of text fields, as well as four items of information that the clinician is to collect about the subject patient. When the clinical site protocol management software reaches this stage in the workflow, it will ask the clinician to obtain these items of information about the current patient and to record them for subsequent use in the protocol. The details of the "Collect pre-study variables" 1 and 2 steps 410 and 414 (Fig. 4) are analogous, except of course the specific tasks listed are different.

Fig. 6 is a detail of the "CALGB 49802 Arm 1" sub-guideline 332 (Fig. 3). As in Fig. 4, Fig. 6 includes a sub-graph (graph 610) and some additional information fields 612. The additional information fields 612 include, among other things, an indication 614 of the first step 618 in the graph, and an indication 616 of the last step 620 of the graph.

Referring to graph 610, the arm 1 sub-guideline begins with a "Decadron pre-treatment" step object 618. The process continues at a "Cycle 1; Day 1" object 622 followed by a choice_object 624 for "Assess for treatment." The clinician may make one of several choices during step 624 including a step of delaying (choice object 626); a step of calling the study chairman (choice object 628); a step of aborting the current patient (choice object 630); or a step of administering the drug under study (choice object 632). If the clinician chooses to delay (object 626), then the patient continues with a "Reschedule next attempt" step 634, followed by another "Decadron pre-treatment" step 618 at a future visit. If in step 624 the clinician chooses to call the study chairman (object 628), then workflow proceeds to choose_step object 636, in which the study chair makes an assessment. The study chair can choose either the delay object 626, the "Give Drug" object 632, or the Abort object 630.

If either the clinician (in object 624) or the study chair (in object 636) chooses to proceed with the "Give Drug" object 632, then workflow proceeds to choice_step object 638 at which the clinician assesses the patient for dose attenuation. In this step, the clinician may choose to give 100% dose (choice object 640) or to give 75% dose (choice object 642). In either case, after dosing, the clinician then performs "Day 8 Cipro" step object 620. That is, on the 8th day, the patient begins a course of Ciprofloxacin (an antibiotic).

Without describing the objects in the graph 610 individually, it will be understood that many of these objects either are themselves specific tasks, or contain task lists which are associated with the particular step, visit or decision represented by the object.

Fig. 7 is a detail of the long term follow-up object 332 (Fig. 3). As mentioned in field 710, the first step in the sub-graph 712 of this object is a long term follow-up visit scenario visit object 714. That is, the sub-guideline illustrated in graph 712 is executed on each of the patient's

long-term follow-up visits. As indicated in field 724, the long term follow-up step 332 (Fig. 3) continues until the patient dies.

Object 716 is a case_object which is dependent upon the patient's number of years post-treatment. If the patient is 1-3 years post-treatment, then the patient proceeds to step object 718, which among other things, schedules the next visit in 3-4 months. If the patient is 4-5 years post-treatment, then the patient proceeds to step object 720, which among other things, schedules the next patient visit in 6 months. If the patient is more than 5 years post-treatment, then the patient proceeds to step object 722, which among other things, schedules the next visit in one year. Accordingly, it can be seen that in the sub-guideline 712, different tasks are performed if the patient is less than 3 years out from therapy, 4-5 out from therapy, or more than 5 years out from therapy. Beneath each of the step objects 718, 720 and 722 are additional workflow tasks that the clinician is required to perform at the current visit.

Fig. 8 is an example detail of one of the objects 718, 720 or 722 (Fig. 7). It includes a graph 810 which begins with a CALGB 49802 f/u visit steps" consultation_branch object 812, followed by seven elementary_action objects 814 and 816a-f (collectively 816). Each of the consultation_action objects 814 and 816 includes a number of workflow tasks not shown in the figures. It can be seen from the names of the objects, however, that the workflow tasks under object 814 are to be performed at every follow-up visit, whereas the workflow tasks under objects 816 are to be performed only annually.

As mentioned, the iCP facilitates integration of all the tools in the overall system of Fig. 1. Integration and especially consistency of language, is facilitated also by the use of CMT 112 (Fig. 1). As mentioned, a CMT provides for a consistent set of concepts, terms, and attributes which allow different tools to "understand" the same structures. CMT concepts include treatments, visits, and laboratory tests, for example. CMT terms include cytoxan, neutropenia, and WBC counts, for example. CMT attributes specify, for example, that cytoxan is a drug which has a dosage and can cause specific side effects, neutropenia is a clinical state described by a series of low white blood cell counts which occur together over a short period of time, and WBC

counts are blood test results which have a certain range and are a measurement whose validity persists for only a few days. Embodiments described herein use CMT to describe patient eligibility criteria (both preliminary eligibility criteria and further eligibility criteria), and also to describe the individual workflow tasks required of the clinician according to the protocol schema represented in the iCP. In one embodiment, the use of CMT is optional, whereas in another embodiment, the use of CMT is enforced. CMT is used in embodiments described herein also to describe patient medical status information that the clinician obtains and records. No existing clinical trials tool makes use of CMT as described herein.

Returning to Fig. 1, in step 114, the protocol designer uses the authoring tool to encode the eligibility criteria and the protocol schema for the clinical trial being designed. For the protocol schema, the authoring tool creates a graphical tool, called a knowledge acquisition (KA) tool (also considered herein to be part of the protocol authoring tool) that is used by protocol authors to enter the specific features of a clinical trial.

Fig. 9 is a flow chart detail of the step 114 (Fig. 1). In order to create an iCP, in a step 910, the protocol designer first selects the appropriate meta-model provided by the central authority in step 110. In most but not all cases, if the clinical trial protocol under development involves the testing of a particular treatment against a particular disease, then the step of selecting a meta-model involves merely the selection of the meta-model that has been created for the relevant disease category. In addition, in the embodiment described herein, each meta-model contains only a single list of relevant preliminary patient eligibility attributes and attribute choices. The step 910 of selecting a meta-model therefore also accomplishes a step of selecting one of a plurality of pre-existing lists of preliminary patient eligibility attributes. (Step 910A). As used herein, a list of eligibility attributes can be "defined" by a number of different methods, one of which is by "selecting" the list (or part of the list) from a plurality of previously defined lists of eligibility attributes. This is the method by which the list of preliminary patient eligibility attributes is defined in step 910A.

After the protocol author selects a meta-model, in step 912, the author then proceeds to design the protocol. The step 912 is a highly iterative process, and includes a step 912A of selecting values for the individual attributes in the preliminary patient eligibility attributes list; a step 912B of establishing further eligibility criteria for the protocol; and a step 912C of designing the workflow of the protocol. Generally the step 912A of selecting values for attributes in the preliminary patient attribute list will precede step 912B of establishing the further eligibility criteria, and both steps 912A and 912B will precede the step 912C of designing the workflow. However, at any time during the process, the protocol author might go back to a previous one of these steps to revise one or more of the eligibility criteria.

Fig. 10 is a flow chart of an advantageous method for the protocol author to establish the patient eligibility criteria. The protocol author is not required to follow the method of Fig. 10, but as will be seen, this method is particularly advantageous. The method of Fig. 10 is shown as a detail of step 914 (Fig. 9), which includes both the steps of selecting values for preliminary patient eligibility attributes and for establishing further eligibility criteria (steps 912A and 912B), rather than as being a detail of step 912A or 912B specifically, because the method of Fig. 10 can be used in either step above, or in both separately, or in both together.

The method of Fig. 10, sometimes referred to herein as an accrual simulation method for establishing patient eligibility criteria, substantially solves the problem mentioned above in which after finalizing a clinical trial protocol, engaging study sites and beginning the enrollment process, it is finally found that the eligibility criteria for the study are too restrictive and that with such criteria it is not possible to enroll sufficient patients in the trial. As mentioned above, these accrual delays are among the most costly and time consuming problems in clinical trials. The method of Fig. 10 addresses this problem by tapping an existing database of patient characteristics (database 116 in Fig. 1) as many times as necessary during the step 912 of designing the protocol, in order to choose eligibility criteria which are likely to enroll sufficient numbers of patients to make the study worthwhile. Generally the effort is to find ways to broaden some or all of the eligibility criteria just enough to satisfy that need, while maintaining

sufficient specificity in the study sample to ensure that the patients being treated are sufficiently similar in respect to clinical conditions, co-existing illnesses, and other characteristics which could modify their response to treatment.

Referring to Fig. 10, in step 1010, the protocol author first establishes initial patient eligibility criteria. Depending on which sub-step(s) of step 914 (Fig. 9) is currently being addressed, this could involve selecting values for the attributes in the previously selected patient eligibility attribute list, or establishing further eligibility criteria, or both. In step 1012, an accrual simulation tool runs the current patient eligibility criteria against the accrual simulation database 116 (Fig. 1), and returns the number or percentage of patients in the database who meet the specified criteria. If the database includes a field specifying each patient's location, then the authoring tool can also return an indication of which clinical sites are likely to be most fruitful in enrolling patients.

In one embodiment, the accrual simulation database includes one or more externally provided patient-anonymized electronic medical records databases. In another embodiment, it includes patient-anonymized data collected from various clinical sites which have participated in past studies. In the latter case the patient-anonymized data typically includes data collected by the site during either preliminary eligibility screening, further eligibility screening, or both. Preferably the database includes information about a large number of anonymous patients, including such information as the patient's current stage of several different diseases (including the possibility in each case that the patient does not have the disease); what type of prior chemotherapy the patient has undergone, if any; what type of prior radiation therapy the patient has undergone; whether the patient has undergone surgery; whether the patient has had prior hormonal therapy; metastases; and the presence of cancer in local lymph nodes. Not all fields will contain data for all patients. Preferably, the fields and values in the accrual simulation database 116 are defined according to the same CMT 112 used in the protocol meta-models and preliminary and further eligibility criteria. Such consistency of data greatly facilitates automation of the accrual simulation step 1012. Note that since the patients included in the accrual

simulation database may be different from and may not accurately represent the universe of patients from which the various clinical sites executing the study will draw, some statistical correction of the numbers returned by the accrual simulation tool may be required to more accurately predict accrual.

5 After accrual is simulated with the patient eligibility criteria established initially in step 1010, then in step 1014, the protocol author decides whether accrual under those conditions will be adequate for the purposes of the study. If not, then in step 1016, the protocol author revises the patient eligibility criteria, again either the values in the preliminary patient eligibility criteria list or in the further eligibility criteria or both, and loops back to try the accrual simulation step 1012 again. The process repeats iteratively until in step 1014 the protocol author is satisfied with the accrual rate, at which point the step of establishing patient eligibility criteria 914 is done (step 1018).

10 In an alternative implementation, the accrual simulation step 1012 is implemented not by querying a preexisting database, but rather by polling clinical sites with the then-current eligibility criteria. Such polling can take place electronically, such as via the Internet. Each site participating in the polling responds by completing a return form, either manually or by automatically querying a local database which indicates the number of patients that the site believes it can accrue who satisfy the indicated criteria. The completed forms are transmitted back to the authoring system, which then makes them available to the protocol author for review.

15 The authoring system makes them available either in raw form, or compiled by clinical site or by other grouping, or merely as a single total. The process then continues with the remainder of the flow chart of Fig. 10.

20 Returning to Fig. 9, both of the steps 912A and 912B preferably take advantage of concepts, terms and attributes already described in the CMT 112 (Fig. 1). The author may use a CMT browser for this purpose, which can either be built into the authoring tool, or a separate application from which the author may cut and paste into the authoring tool. In addition to the literal concept, terms and attributes entries, the CMT 112 preferable also contains "screen

25

questions”, which are more descriptive than the actual entries names themselves, and which help both the protocol author and subsequent users of protocol to interpret each entry consistently.

The step 912C of designing the workflow, results in a graph like those shown in Figs. 3, 4, 6, 7 and 8 described above. As noted above, the authoring tool allows the protocol author to define not only patient management tasks, but also data management tasks. Such data management tasks can include such items as obtaining informed consent, completing forms regarding patient visits that have taken place, entering workflow progress data (e.g. confirmation that each patient management task identified for a particular visit was in fact performed; and which arm of a branch the patient has taken), and patient medical status information (e.g., patient assessment observations). In addition, preferably the concepts, terms and attributes used in the workflow graph make reference to entries in the CMT database 112. Even more preferably, as in the patient eligibility criteria, the authoring tool enforces reference to a CMT for all concepts, terms and attributes used in the workflow tasks. Again, a CMT browser may be used.

The result of step 912 is an iCP database, such as the one described above with respect to Figs. 2-8. As can be seen, the iCP contains both eligibility criteria and workflow tasks organized as a graph. The workflow tasks include both patient management tasks and data management tasks, and either type can be positioned on the graph for execution either pre- or post-enrollment.

In step 916, the iCP is written to an iCP database library 118 (Fig. 1), which can be maintained by the central authority. The iCP database library 118 is essentially a database of iCP databases, and includes a series of pointers to each of the individual iCP databases. In an embodiment, the iCP database library also includes appropriate entries to support access restrictions on the various iCP databases, so that access may be given to certain inquirers and not others.

For example, while certain clinical trial protocols are typically publicly available, such as those sponsored by public interest institutions, others, such as those funded by pharmaceutical companies, usually need to be maintained in strict confidence. Those which do not require

confidentiality might have no access restrictions other than subscription or membership in the central authority which maintains the iCP library 118, whereas those that do require confidentiality are accessible only by the sponsor itself and by specific clinical sites and SMOs who have signed confidentiality agreements with the sponsor. In an embodiment, the iCP database library 118 includes an access control list for each iCP database, which lists which users (including kinds of users) are allowed access to that database, and optionally what kind of access is permitted for each user (e.g., read/write access, or read access but not write access). The sponsor of each iCP is the only entity that can modify the access control list for the iCP.

Because the process of designing a clinical trial protocol can be extremely complex, usually requiring extensive medical and clinical knowledge, in one aspect of the invention the task is facilitated by allowing subprotocol components to be stored in a library after they are created, and re-used later in other protocols. Subprotocol components can themselves include subprotocol subcomponents which are themselves considered herein to be subprotocol components. In the object-oriented embodiments described above with respect to Figs. 2-8 and 11-25, the subprotocol components can be any object in an iCP, and subcomponents of such subprotocol components can be any sub-objects of such objects. Referring to Fig. 1, the subprotocol components are stored in a re-usable iCP component library 130, and they are drawn upon as needed by protocol designers in step 114, as well as written to by protocol designers (or sponsors) after an iCP or a portion of an iCP is complete.

In an embodiment, access to the subprotocol components in the re-usable iCP component library 130 is controlled in the same manner as is access to the iCP databases in iCP database library 118. This can be accomplished in various different ways in different embodiments. In one embodiment, the sponsor writes its subprotocol components into the library 130 with whatever granularity is desired. Each such component has associated therewith its own independent access control list, so access to the subprotocol components in the library 130 is controlled with the same granularity that the sponsor used in writing the components into the library 130. In another embodiment, access control lists are applied hierarchically within a subprotocol component,

permitting the granularity of access control to be finer than the granularity of objects written into the library 130 by the sponsor. In yet another embodiment the re-usable iCP component library 130 is physically the same as the iCP database library 118, and access control lists are associated with subprotocol components as well as with entire iCP databases.

5 In step 120, the central authority “distributes” the iCPs from the iCP database library 118 to clinical sites which are authorized to receive them. Authorization typically involves the site being part of the central authority’s network of clinical sites, and also authorization by the sponsor of each study. In one embodiment, “distribution” involves merely making the appropriate iCP databases available to the appropriate clinical sites. In another embodiment, “distribution” involves downloading the appropriate iCP databases from the iCP database library 118, into a site-local database of authorized iCPs. In yet another embodiment, the entire library 118 is downloaded to all of the member clinical sites, but keys are provided to each site only for the protocols for which that site is authorized access. Preferably, the central authority maintains the iCP databases only on the central server and makes them available using a central application service provider (ASP) and thin-client model that supports multiple user devices including work stations, laptop computers and hand held devices. The availability of hand held devices allows the deployment of “intelligent” point of care data capture devices in which all protocol-specific, visit-specific and patient-specific required data elements, and their associated data validation rules, can be automatically created using information contained within the iCP. For example, an iCP can specify that if a patient exhibits evidence of an adverse event, additional data collection elements are required. Intelligent point of care data capture can detect the existence of an adverse event and add new required data elements to completely describe the event.

20 In step 122, the individual clinical sites conduct clinical trials in accordance with one or more iCPs. The clinical site uses either a single software tool or a collection of different software tools to perform a number of different functions in this process, all driven by the iCP database. In one embodiment, in which Protégé was used as a clinical trials protocol authoring tool, a related set of “middleware” components similar to the EON execution engine originally created

by Stanford University's Section on Medical Informatics, can be used to create appropriate user applications and tools which understand and which in a sense "execute" the iCP data structure. EON and its relationship to Protégé are described in the above-incorporated SMI Report Number SMI-1999-0801, and also in the following two publications, both incorporated by
5 reference herein: Musen, et. al., "EON: A Component-Based Approach to Automation of Protocol-Directed Therapy, SMI Report No. SMI-96-0606, JAMIA 3:367-388 (1996); and Musen, "Domain Ontologies in Software Engineering: Use of Protege with the EON Architecture," Methods of Information in Medicine 37:540-550, SMI Report No. SMI-97-0657 (1998).

10 These middleware components support the development of domain-independent problem-solving methods (PSMs), which are domain-independent procedures that automate tasks to be solved. For example, the software which guides clinical trial procedures at the clinical site uses an eligibility-determination PSM to evaluate whether a particular patient is eligible for one or more protocols. The PSM is domain-independent, meaning that the same software
15 component can be used for oncology trials or diabetes trials, and for any patient. All that changes between different trials is the protocol description, represented in the iCP. This approach is far more robust and scalable than creating a custom rule-based system for each trial, as was done in the prior art, since the same tested components can be reused over and again from trial to trial. In addition to the eligibility determination PSM, there is a therapy-planning PSM that directs
20 therapy based on the protocol and patient data, and the accrual simulation PSM described elsewhere herein, among others.

Because of the ability to support domain-independent PSMs, the iCPs of the embodiments described herein enable automation of the entire trials process from protocol authoring to database lock. For example, the iCP is used to create multiple trial management
25 tools, including electronic case report forms, data validation logic, trial performance metrics, patient diaries and document management reports. The iCP data structures can be used by multiple tools to ensure that the tool performs in strict compliance with the clinical protocol

requirements. For example, the accrual simulation tool described above with respect to Fig. 10 is implemented as a domain-independent PSM. Similarly, an embodiment can also include a PSM that clinical sites can use to simulate their own accrual in advance of signing on to perform a given clinical trial. A single PSM is used to simulate accrual into a variety of studies, because the patient eligibility criteria are all identified in a predetermined format in the iCP for each study. Another PSM helps clinical sites identify likely patients for a given clinical trial. Yet another PSM guides clinicians through the visit-specific workflow tasks for each given patient as required by the protocol. The behavior of all these tools is guaranteed to be consistent with the protocol even as it evolves and changes because they all use the same iCP. The tools can also be incorporated into a library that can be re-used for the next relevant trial, thus permitting knowledge to be transferred across trials rather than being re-invented each time.

Fig. 26 is a flow chart detail of step 122 (Fig. 1). The steps in Fig. 1 typically use or contribute to a site-private patient information database 2610, which contains a number of different kinds of patient information. Because this information is maintained in conjunction with the identity of the patient, these databases 2610 are typically confidential to the clinical site or SMO, and not made available to anyone else, including study sponsors and the central authority. In one embodiment, the patient information database 2610 is located physically at the clinical site. In another embodiment, storage of the database 2610 is provided by the central authority as a service to clinical sites. In the latter embodiment, cryptographic or other security measures may be taken to ensure that no entity but the individual clinical site can view any confidential patient information.

As shown in Fig. 1, the central authority also maintains its own "operational" database 124, containing patient-anonymized patient information. The operational database 124 can be separate from the confidential patient information database(s) 2610 on which case a patient anonymized version of the patient information database 2610, or at least portions of database 2610, are transferred periodically for inclusion in an operational database 124 (Fig. 1).

Alternatively, the two databases can be integrated together into one, with the central authority being denied access to sensitive patient-confidential information cryptographically.

Referring to Fig. 26, when a particular site is considering signing on to a clinical study for which it is authorized, it can first perform an accrual simulation, based on the data in its own patient information database 2610, to determine whether it is likely to accrue sufficient numbers of patients to make its participation in the study worthwhile (Step 2612). As mentioned, step 2612 is performed by a PSM which references the preliminary eligibility criteria and, in some embodiments, the further eligibility criteria for the candidate study. This PSM queries the site's information database 2610. Preferably the patient information database 2610 includes an indication of which patients are already enrolled in clinical trials, and excludes them from the predicted accrual count reported by the local accrual simulation tool.

After the clinical site has decided to proceed with a study, then it can use either a "Find-Me Patients" tool (step 2614) or a "QuickScreen" tool (step 2616) to identify enrollment candidates. The "Find-Me Patients" tool is either the same or different from the local accrual simulation tool, and it operates to develop a list of patients from its patient information database 2610 who are likely to satisfy the eligibility criteria for a particular protocol. Again, this local "Find-Me Patients" tool makes appropriate queries to the patient information database 2610 for patients who are believed to satisfy the preliminary eligibility criteria for the subject protocol.

The QuickScreen tool, on the other hand, for each candidate patient, compares that patient's characteristics with the preliminary eligibility criteria for all of the studies which are relevant to that clinical site. In one embodiment, this is an automated process driven by the eligibility criteria for all the relevant protocols, and which queries the site's patient information database 2610. In an embodiment, the QuickScreen tool references only those patient characteristics already stored in the patient information database 2610, for which informed consent from the patient was not originally required, or for which the patient previously gave his or her informed consent for a different purpose. Note that the iCPs in the present embodiment do not actually include the preliminary criteria with the iCP. Rather, the preliminary criteria are

provided separately by the central authority in a unified "QuickScreen database". In another embodiment, the preliminary eligibility criteria can be either included directly in the iCP or identified by pointer from the iCP. As used herein, a database "identifies" certain information if it contains the information or if it points to the information, whether or not through one or more levels of indirection.

The studies that the site includes in the QuickScreen step 2616 for a given candidate patient might be all studies for which the site has authorization. Alternatively, the list of candidate studies can be limited to a particular disease area, and/or by the patient's own stated preferences, and/or by other study selection criteria applied by the site. If the QuickScreen step 2616 involves manual entry of newly obtained patient data, then preferably such data is added to the patient information database 2610.

If the candidate patient is determined to satisfy the preliminary eligibility criteria for one or more clinical trials, in step 2616, then in step 2618, the clinical site evaluates the candidate patient's medical characteristics against the further eligibility criteria for one or more of the surviving studies. This step can be performed either serially, ruling out each study before evaluating the patient against the further eligibility criteria of the next study, or partially or entirely in parallel. Preferably the step 2618 for each given study is managed by the workflow management PSM, making reference to the iCP for the given study. The iCP may direct certain patient assessment tasks which are relevant to the further eligibility criteria of the particular study. It also directs the data management tasks which are appropriate so that clinical site personnel enter the patient assessment results into the system for comparison against the further eligibility criteria. Furthermore, as described in more detail elsewhere herein, the iCP can further direct the obtaining of informed consent either at the beginning of the further eligibility evaluation step 2618, or at an appropriate time in the middle when informed consent is required before proceeding. Moreover, where possible, all data entered into the system during step 2618 is recorded in the clinical site's patient information database 2610.

After step 2618, if the patient is still eligible for one or more clinical trials, then in step 2620, the workflow management tool directs and manages the process of enrolling the patient in one of the trials. The fact of enrollment is recorded in the patient information database 2610. In step 2622, the workflow management tool, governed by the iCP database, directs all of the workflow task required at each patient visit in order to ensure compliance with the protocol. As mentioned, in accordance with the protocol, information about the patient's progress through the workflow tasks is written into the patient information database 2610, as is certain additional data called for in the data management tasks of the protocol. In one embodiment, the workflow management tool records performance/non-performance of tasks on a per patient, per visit basis. An another embodiment, more detailed patient progress information is recorded.

Returning to Fig. 1, as can be seen, patient-anonymized medical information as well as workflow progress information is uploaded from the patient information databases 2610 at each of the clinical sites in the network, to a central operational database 124. In various embodiments, some or all of this data is uploaded immediately as created, and/or on a periodic basis. The clinical study sponsors have access to the data in order to permit real time or near-real-time (depending on upload frequency) monitoring of the progress of their studies (Step 126), and the central authority also analyzes the data in the operational database 124 in order to rate the performance of each site against clinical site performance metrics (Step 128).

Such performance metrics include a site's accrual performance (actual vs. expected accrual rates), and the site's ability to deliver timely, accurate information as trials progress. The latter metrics can include such measurements as the time to complete tasks, the time from visit to entered CRF, the time from visit to closed CRF, the time from last visit to closed patient, and the time from last patient last visit to closed study. Prior art systems exist for collecting site performance data, but these systems have captured only very narrow metrics such as completion of case report forms, and the number of audits that have been conducted on the site. The prior art systems are also entirely paper-based. Most importantly, the prior art systems evaluate site performance only for a single specific study; they do not accumulate performance metrics across

multiple studies at a given clinical site. In the embodiment described herein, however, the central authority gathers performance data electronically over the course of more than one study being conducted at each participating clinical site. In step 128 the central authority evaluates each site's performance against performance metrics, and these evaluations are based on each site's proven and documented past performance, typically over multiple studies conducted. Preferably, the central authority makes its site performance evaluations available to sponsors such that the best sites can be chosen for conducting clinical trials.

Study sponsors also have access to the data in the operational database 124 in order to identify promising clinical sites at which a particular new study might be conducted. For this purpose, the patient information that has been uploaded to the operational database 124 includes an indication of the clinical site at which the data was collected. The sponsor then executes a "Find-Me-Sites" PSM which queries the operational database 124 in accordance with the iCP or preliminary eligibility criteria applicable to the new protocol, and the PSM returns the number or percentage of patients in the database from each site who satisfy or might satisfy the eligibility criteria.

As used herein, a given event or value is "responsive" to a predecessor event or value if the predecessor event or value influenced the given event or value. If there is an intervening step or time period, the given event or value can still be "responsive" to the predecessor event or value. If the intervening step combines more than one event or value, the output of the step is considered "responsive" to *each* of the event or value inputs. If the given event or value is the same as the predecessor event or value, this is merely a degenerate case in which the given event or value is still considered to be "responsive" to the predecessor event or value. "Dependency" of a given event or value upon another event or value is defined similarly.

The foregoing description of preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in this art. In particular, and without

limitation, any and all variations described, suggested or incorporated by reference in the Background section of this patent application are specifically incorporated by reference into the description herein of embodiments of the invention. The embodiments described herein were chosen and described in order to best explain the principles of the invention and its practical application, thereby enabling others skilled in the art to understand the invention for various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

5

11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
157
158
159
160
161
162
163
164
165
166
167
168
169
170
171
172
173
174
175
176
177
178
179
180
181
182
183
184
185
186
187
188
189
190
191
192
193
194
195
196
197
198
199
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
271
272
273
274
275
276
277
278
279
280
281
282
283
284
285
286
287
288
289
290
291
292
293
294
295
296
297
298
299
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
325
326
327
328
329
330
331
332
333
334
335
336
337
338
339
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
358
359
360
361
362
363
364
365
366
367
368
369
370
371
372
373
374
375
376
377
378
379
380
381
382
383
384
385
386
387
388
389
390
391
392
393
394
395
396
397
398
399
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
425
426
427
428
429
430
431
432
433
434
435
436
437
438
439
440
441
442
443
444
445
446
447
448
449
450
451
452
453
454
455
456
457
458
459
460
461
462
463
464
465
466
467
468
469
470
471
472
473
474
475
476
477
478
479
480
481
482
483
484
485
486
487
488
489
490
491
492
493
494
495
496
497
498
499
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
525
526
527
528
529
530
531
532
533
534
535
536
537
538
539
540
541
542
543
544
545
546
547
548
549
550
551
552
553
554
555
556
557
558
559
560
561
562
563
564
565
566
567
568
569
570
571
572
573
574
575
576
577
578
579
580
581
582
583
584
585
586
587
588
589
590
591
592
593
594
595
596
597
598
599
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
632
633
634
635
636
637
638
639
640
641
642
643
644
645
646
647
648
649
650
651
652
653
654
655
656
657
658
659
660
661
662
663
664
665
666
667
668
669
670
671
672
673
674
675
676
677
678
679
680
681
682
683
684
685
686
687
688
689
690
691
692
693
694
695
696
697
698
699
700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
725
726
727
728
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
752
753
754
755
756
757
758
759
760
761
762
763
764
765
766
767
768
769
770
771
772
773
774
775
776
777
778
779
780
781
782
783
784
785
786
787
788
789
790
791
792
793
794
795
796
797
798
799
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
825
826
827
828
829
830
831
832
833
834
835
836
837
838
839
840
841
842
843
844
845
846
847
848
849
850
851
852
853
854
855
856
857
858
859
860
861
862
863
864
865
866
867
868
869
870
871
872
873
874
875
876
877
878
879
880
881
882
883
884
885
886
887
888
889
890
891
892
893
894
895
896
897
898
899
900
901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
923
924
925
926
927
928
929
930
931
932
933
934
935
936
937
938
939
940
941
942
943
944
945
946
947
948
949
950
951
952
953
954
955
956
957
958
959
960
961
962
963
964
965
966
967
968
969
970
971
972
973
974
975
976
977
978
979
980
981
982
983
984
985
986
987
988
989
990
991
992
993
994
995
996
997
998
999
1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
1025
1026
1027
1028
1029
1030
1031
1032
1033
1034
1035
1036
1037
1038
1039
1040
1041
1042
1043
1044
1045
1046
1047
1048
1049
1050
1051
1052
1053
1054
1055
1056
1057
1058
1059
1060
1061
1062
1063
1064
1065
1066
1067
1068
1069
1070
1071
1072
1073
1074
1075
1076
1077
1078
1079
1080
1081
1082
1083
1084
1085
1086
1087
1088
1089
1090
1091
1092
1093
1094
1095
1096
1097
1098
1099
1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
1125
1126
1127
1128
1129
1130
1131
1132
1133
1134
1135
1136
1137
1138
1139
1140
1141
1142
1143
1144
1145
1146
1147
1148
1149
1150
1151
1152
1153
1154
1155
1156
1157
1158
1159
1160
1161
1162
1163
1164
1165
1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176
1177
1178
1179
1180
1181
1182
1183
1184
1185
1186
1187
1188
1189
1190
1191
1192
1193
1194
1195
1196
1197
1198
1199
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
1225
1226
1227
1228
1229
1230
1231
1232
1233
1234
1235
1236
1237
1238
1239
1240
1241
1242
1243
1244
1245
1246
1247
1248
1249
1250
1251
1252
1253
1254
1255
1256
1257
1258
1259
1260
1261
1262
1263
1264
1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
1325
1326
1327
1328
1329
1330
1331
1332
1333
1334
1335
1336
1337
1338
1339
1340
1341
1342
1343
1344
1345
1346
1347
1348
1349
1350
1351
1352
1353
1354
1355
1356
1357
1358
1359
1360
1361
1362
1363
1364
1365
1366
1367
1368
1369
1370
1371
1372
1373
1374
1375
1376
1377
1378
1379
1380
1381
1382
1383
1384
1385
1386
1387
1388
1389
1390
1391
1392
1393
1394
1395
1396
1397
1398
1399
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
1416
1417
1418
1419
1420
1421
1422
1423
1424
1425
1426
1427
1428
1429
1430
1431
1432
1433
1434
1435
1436
1437
1438
1439
1440
1441
1442
1443
1444
1445
1446
1447
1448
1449
1450
1451
1452
1453
1454
1455
1456
1457
1458
1459
1460
1461
1462
1463
1464
1465
1466
1467
1468
1469
1470
1471
1472
1473
1474
1475
1476
1477
1478
1479
1480
1481
1482
1483
1484
1485
1486
1487
1488
1489
1490
1491
1492
1493
1494
1495
1496
1497
1498
1499
1500
1501
1502
1503
1504
1505
1506
1507
1508
1509
1510
1511
1512
1513
1514
1515
1516
1517
1518
1519
1520
1521
1522
1523
1524
1525
1526
1527
1528
1529
1530
1531
1532
1533
1534
1535
1536
1537
1538
1539
1540
1541
1542
1543
1544
1545
1546
1547
1548
1549
1550
1551
1552
1553
1554
1555
1556
1557
1558
1559
1560
1561
1562
1563
1564
1565
1566
1567
1568
1569
1570
1571
1572
1573
1574
1575
1576
1577
1578
1579
1580
1581
1582
1583
1584
1585
1586
1587
1588
1589
1590
1591
1592
1593
1594
1595
1596
1597
1598
1599
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
1627
1628
1629
1630
1631
1632
1633
1634
1635
1636
1637
1638
1639
1640
1641
1642
1643
1644
1645
1646
1647
1648
1649
1650
1651
1652
1653
1654
1655
1656
1657
1658
1659
1660
1661
1662
1663
1664
1665
1666
1667
1668
1669
1670
1671
1672
1673
1674
1675
1676
1677
1678
1679
1680
1681
1682
1683
1684
1685
1686
1687
1688
1689
1690
1691
1692
1693
1694
1695
1696
1697
1698
1699
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
1725
1726
1727
1728
1729
1730
1731
1732
1733
1734
1735
1736
1737
1738
1739
1740
1741
1742
1743
1744
1745
1746
1747
1748
1749
1750
1751
1752
1753
1754
1755
1756
1757
1758
1759
1760
1761
1762
1763
1764
1765
1766
1767
1768
1769
1770
1771
1772
1773
1774
1775
1776
1777
1778
1779
1780
1781
1782
1783
1784
1785
1786
1787
1788
1789
1790
1791
1792
1793
1794
1795
1796
1797
1798
1799
1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
1825
1826
1827
1828
1829
1830
1831
1832
1833
1834
1835
1836
1837
1838
1839
1840
1841
1842
1843
1844
1845
1846
1847
1848
1849
1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
1863
1864
1865
1866
1867
1868
1869
1870
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
1953
1954
1955
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
2035
2036
2037
2038
2039
2040
2041
2042
2043
2044
2045
2046
2047
2048
2049
2050
2051
2052
2053
2054
2055
2056
2057
2058
2059
2060
2061
2062
2063
2064
2065
2066
2067
2068
2069
2070
2071
2072
2073
2074
2075
2076
2077
2078
2079
2080
2081
2082
2083
2084
2085
2086
2087
2088
2089
2090
2091
2092
2093
2094
2095
2096
2097
2098
2099
2100
2101
2102
2103
2104
2105
2106
2107
2108
2109
2110
2111
2112
2113
2114
2115
2116
2117
2118
2119
2120
2121
2122
2123
2124
2125
2126
2127
2128
2129
2130
2131
2132
2133
2134
2135
2136
2137
2138
2139
2140
2141
2142
2143
2144
2145
2146
2147
2148
2149
2150
2151
2152
2153
2154
2155
2156
2157
2158
2159
2160
2161
2162
2163
2164
2165
2166
2167
2168
2169
2170
2171
2172
2173
2174
2175
2176
2177
2178
2179
2180
2181
2182
2183
2184
2185
2186
2187
2188
2189
2190
2191
2192
2193
2194
2195
2196
2197
2198
2199
2200
2201
2202
2203
2204
2205
2206
2207
2208
2209
2210
2211
2212
2213
2214
2215
2216
2217
2218
2219
2220
2221

CLAIMS

1 1. At least one computer readable medium collectively carrying a machine readable
2 database identifying:

3 first patient eligibility criteria for a first clinical trial protocol; and
4 a first plurality of workflow tasks for said first clinical trial protocol, said first plurality
5 of workflow tasks including post-enrollment workflow tasks.

1 2. A medium according to claim 1, wherein said database further identifies
2 preliminary patient eligibility criteria applicable to said first clinical trial protocol.

1 3. A medium according to claim 1, wherein said database identifies a term by
2 reference to a controlled medical terminology database.

1 4. A method according to claim 1, wherein said first plurality of workflow tasks
2 includes data management tasks.

1 5. A method according to claim 4, wherein said post-enrollment workflow tasks
2 include post-enrollment patient management tasks.

1 6. A method according to claim 4, wherein said data management tasks include an
2 instruction for a clinician to complete a specified form.

1 7. A method according to claim 4, wherein said data management tasks include an
2 instruction for a clinician to obtain informed consent of a patient.

1 8. A method according to claim 7, wherein said first plurality of workflow tasks
2 includes an instruction to obtain specified patient medical information before said instruction to
3 obtain informed consent.

1 9. A method according to claim 8, wherein said first plurality of workflow tasks
2 includes a pre-enrollment instruction to obtain specified patient medical information after said
3 instruction to obtain informed consent.

1 10. A method according to claim 7, wherein said data management tasks further
2 include an instruction to enroll a patient into a clinical trial.

1 11. A method according to claim 1, wherein said data management tasks include an
instruction to enroll a patient into a clinical trial.

1 12. At least one computer readable medium collectively carrying a machine readable
2 database identifying:
3 a plurality of patient management tasks for a first clinical trial protocol; and
4 a plurality of data management tasks for said first clinical trial protocol.

1 13. A medium according to claim 12, wherein said database further identifies patient
2 eligibility criteria applicable to said first clinical trial protocol.

1 14. A medium according to claim 12, wherein said database identifies a term by
2 reference to a controlled medical terminology database.

1 15. A method according to claim 12, wherein said plurality of patient management
2 tasks includes post-enrollment patient management tasks.

1 23. A method according to claim 22, further comprising the step of authorizing each
2 of said clinical sites to perform trials of the clinical trial protocols to which the site is provided
3 access.

1 24. A method according to claim 22, wherein said step of providing access comprises
2 the step of downloading the database for a particular one of said protocols to a particular one
3 of said clinical sites.

1 25. A method according to claim 22, wherein said step of providing access comprises
2 the step of allowing a particular one of said clinical sites remote access to the database for a
3 particular one of said protocols.

1 26. A method according to claim 22, further comprising the step of downloading at
2 least a subset of said databases to a particular one of said clinical sites,
3 wherein said step of providing access comprises the step of allowing said particular
4 clinical site to access one of the databases downloaded.

1 27. A method according to claim 22, further comprising the step of receiving said
2 databases from a plurality of different protocol designers.

1 28. A method according to claim 22, wherein each of said databases identifies:
2 patient eligibility criteria for the respective clinical trial protocol; and
3 a plurality of workflow tasks for the respective clinical trial protocol, said plurality of
4 workflow tasks including post-enrollment workflow tasks.

1 16. A method according to claim 12, wherein said plurality of data management tasks
2 includes an instruction for a clinician to complete a specified form.

1 17. A method according to claim 12, wherein said plurality of data management tasks
2 includes an instruction for a clinician to obtain informed consent of a patient.

1 18. A method according to claim 17, wherein said plurality of patient management
2 tasks includes an instruction to obtain specified patient medical information before said
3 instruction to obtain informed consent.

1 19. A method according to claim 18, wherein said plurality of patient management
2 tasks further includes a pre-enrollment instruction to obtain specified patient medical information
3 after said instruction to obtain informed consent.

1 20. A method according to claim 17, wherein said plurality of data management tasks
2 further includes an instruction to enroll a patient into a clinical trial.

1 21. A method according to claim 12, wherein said plurality of data management tasks
includes an instruction to enroll a patient into a clinical trial.

1 22. A clinical trials method, comprising the steps of:
2 storing a plurality of databases each identifying, for a respective clinical trial protocol,
3 at least one member of the group consisting of patient eligibility criteria and protocol workflow
4 tasks; and
5 providing access to individual ones of said databases by each of a plurality of clinical sites
6 in accordance with predetermined site eligibility criteria.

1 29. A method according to claim 28, wherein each of said databases further identifies
2 preliminary patient eligibility criteria applicable to the respective clinical trial protocol.

1 30. A method according to claim 22, wherein each of said databases identifies:
2 a plurality of patient management tasks for the respective clinical trial protocol; and
3 a plurality of data management tasks for the respective clinical trial protocol.

1 31. At least one computer readable medium collectively carrying a library identifying
2 a plurality of machine readable protocol databases each identifying, for a respective clinical trial
3 protocol, at least one member of the group consisting of patient eligibility criteria and protocol
4 workflow tasks.

1 32. A medium according to claim 31, further comprising means for providing access
2 to individual ones of said protocol databases by each of a plurality of clinical sites in accordance
3 with predetermined site eligibility criteria.

1 33. A medium according to claim 31, wherein different ones of said protocol
2 databases were prepared by different protocol designers.

1 34. A medium according to claim 31, wherein each of said protocol databases
2 identifies:
3 patient eligibility criteria for the respective clinical trial protocol; and
4 a plurality of workflow tasks for the respective clinical trial protocol, said plurality of
5 workflow tasks including post-enrollment workflow tasks.

1 35. A medium according to claim 34, wherein each of said protocol databases further
2 identifies preliminary patient eligibility criteria applicable to the respective clinical trial protocol.

1 36. A medium according to claim 31, wherein each of said protocol databases
2 identifies:

3 a plurality of patient management tasks for the respective clinical trial protocol; and
4 a plurality of data management tasks for the respective clinical trial protocol.

1 37. A medium according to claim 31, wherein at least one of said protocol databases
2 identifies a term by reference to a controlled medical terminology database.

1 38. A medium according to claim 37, wherein each of said protocol databases
2 identifies a term by reference to a controlled medical terminology database.

1 39. A medium according to claim 37, wherein each of a plurality of said protocol
2 databases identifies a term by reference to a common controlled medical terminology database.

1 40. A medium according to claim 31, wherein different ones of said clinical trial
2 protocols address different disease categories.

1 41. A medium according to claim 31, wherein each of said machine readable protocol
2 databases includes software objects instantiated from a corresponding predefined set of object
3 classes.

1 42. A medium according to claim 41, wherein all of said machine readable protocol
2 databases include software objects instantiated from a common predefined set of object classes.

1 43. A medium according to claim 41, wherein a first one of said machine readable
2 protocol databases includes software objects instantiated from a first predefined set of object

3 classes, and a second one of said machine readable protocol databases includes software objects
4 instantiated from a second predefined set of object classes different from said first predefined set
5 of object classes.

1 44. A medium according to claim 41, wherein the machine readable protocol
2 databases are for clinical trial protocols in a plurality of disease categories,
3 and wherein the software objects included in each given one of said machine readable
4 protocol databases are instantiated from a set of object classes which corresponds to and is
5 specific to the disease category of the clinical trial protocol of the given protocol database.

1 45. A method for designing clinical trial protocols, comprising the steps of:
2 defining an initial group of first eligibility criteria for patients to be included in clinical
3 trials of a particular clinical trial protocol; and
4 simulating patient accrual in dependence upon said initial group of first eligibility criteria.

1 46. A method according to claim 45, further comprising the step of revising said
2 initial group of first eligibility criteria in dependence upon said step of simulating.

1 47. A method according to claim 46, further comprising the step of iteratively
2 repeating said steps of simulating and revising, until the step of simulating predicts an acceptable
3 patient accrual rate.

1 48. A method according to claim 45, wherein said step of defining an initial group of
2 first eligibility criteria comprises the steps of:
3 selecting a first list of patient attributes from a plurality of pre-existing lists of patient
4 attributes; and

5 establishing each of the first eligibility criteria in said initial group by assigning an initial
6 condition to a corresponding one of the attributes in said first list, each of said criteria being
7 satisfied only if a patient meets the condition assigned to the corresponding attribute, and each
8 of said criteria being a member of the group consisting of inclusion criteria and exclusion criteria.

1 49. A method according to claim 45, further comprising the steps of:
2 selecting, from a plurality of pre-existing lists of patient attributes, a first one of said lists
3 for use in defining preliminary eligibility criteria for said particular clinical trial protocol; and
4 establishing each of said preliminary eligibility criteria by assigning a condition to a
5 corresponding one of the attributes in said first list, each of said criteria being satisfied only if a
6 patient meets the condition assigned to the corresponding attribute, and each of said criteria
7 being a member of the group consisting of inclusion criteria and exclusion criteria,
8 and wherein said first eligibility criteria are further eligibility criteria to be applied only
9 to patients who have passed preliminary eligibility for said particular protocol as determined by
10 said preliminary eligibility criteria.

1 50. A method according to claim 45, wherein said first eligibility criteria include both
2 preliminary eligibility criteria and further eligibility criteria, said further eligibility criteria to be
3 applied only to patients who have passed preliminary eligibility for said particular protocol as
4 determined by said preliminary eligibility criteria.

1 51. A method for designing clinical trial protocols, comprising the steps of:
2 defining an initial group of first eligibility criteria for patients to be included in clinical
3 trials of a particular clinical trial protocol; and
4 polling clinical sites for expected patient accrual in dependence upon said initial group
5 of first eligibility criteria.

1 52. A method according to claim 51, further comprising the step of revising said
2 initial group of first eligibility criteria in dependence upon said step of polling.

1 53. A method according to claim 52, further comprising the step of iteratively
2 repeating said steps of polling and revising, until the step of polling predicts an acceptable total
3 patient accrual rate.

1 54. A method according to claim 51, wherein said step of defining an initial group of
2 first eligibility criteria comprises the steps of:

3 selecting a first list of patient attributes from a plurality of pre-existing lists of patient
4 attributes; and

5 establishing each of the first eligibility criteria in said initial group by assigning an initial
6 condition to a corresponding one of the attributes in said first list, each of said criteria being
7 satisfied only if a patient meets the condition assigned to the corresponding attribute, and each
8 of said criteria being a member of the group consisting of inclusion criteria and exclusion criteria.

1 55. A method according to claim 51, further comprising the steps of:

2 selecting, from a plurality of pre-existing lists of patient attributes, a first one of said lists
3 for use in defining preliminary eligibility criteria for said particular clinical trial protocol; and

4 establishing each of said preliminary eligibility criteria by assigning a condition to a
5 corresponding one of the attributes in said first list, each of said criteria being satisfied only if a
6 patient meets the condition assigned to the corresponding attribute, and each of said criteria
7 being a member of the group consisting of inclusion criteria and exclusion criteria,

8 and wherein said first eligibility criteria are further eligibility criteria to be applied only
9 to patients who have passed preliminary eligibility for said particular protocol as determined by
10 said preliminary eligibility criteria.

1 56. A method according to claim 51, wherein said first eligibility criteria include both
2 preliminary eligibility criteria and further eligibility criteria, said further eligibility criteria to be
3 applied only to patients who have passed preliminary eligibility for said particular protocol as
4 determined by said preliminary eligibility criteria.

1 57. A method for clinical trials, comprising the steps of:
2 obtaining a first subset of patient information items about each of a plurality of patients;
3 comparing the first subset of patient information items about each of said plurality of
4 patients against first eligibility criteria for a first clinical trial for a purpose of determining patient
5 eligibility for said first clinical trial;
6 recording said first subset of patient information items about each of said patients to a
7 database; and subsequently
8 comparing the first subset of patient information items about each of said patients from
9 said database against second eligibility criteria for a second clinical trial for a purpose of
10 determining patient eligibility for said second clinical trial.

1 58. A method according to claim 57, further comprising the steps of:
2 obtaining a second subset of patient information items about each of at least a subset of
3 said plurality of patients, after said step of comparing the first subset of patient information items
4 about each of said patients against first eligibility criteria for a first clinical trial for a purpose of
5 determining patient eligibility for said first clinical trial; and
6 comparing the second subset of patient information items about each of said subset of
7 patients against second eligibility criteria for said first clinical trial for a purpose of determining
8 patient eligibility for said first clinical trial.

1 59. A method according to claim 58, further comprising the step of recording said
2 second subset of patient information items about each of said subset of patients to said database.

1 60. A method according to claim 59, further comprising the step of comparing the
2 second subset of patient information items about each of said subset of patients from said
3 database against eligibility criteria for said second clinical trial for a purpose of determining
4 patient eligibility for said second clinical trial.

1 61. A method according to claim 57, further comprising the steps of:
2 obtaining a preliminary subset of information items about each of a group of patients
3 including said plurality of patients; and
4 comparing the preliminary subset of patient information items about each patient in said
5 group of patients against preliminary eligibility criteria for said first clinical trial prior to said step
6 of comparing the first subset of patient information items about each of said plurality of patients
7 against first eligibility criteria.

1 62. A method according to claim 61, further comprising the step of recording said
2 preliminary subset of patient information items about each patient in said group of patients to
3 said database.

1 63. A method according to claim 61, further comprising the step of selecting said
2 plurality of patients in dependence upon said step of comparing the preliminary subset of patient
3 information items.

1 64. A method according to claim 57, wherein said step of recording said first subset
2 of information items about each of said patients to a database includes the step of recording in
3 said database an identity of the patient to which each of said information items relates.

1 65. A method according to claim 57, wherein at least one of said first eligibility
2 criteria is defined according to a predefined controlled medical terminology.

1 66. A method for designing clinical trial protocols, comprising the steps of:
2 selecting, from a plurality of pre-existing lists of patient attributes, a first one of said lists
3 for use in defining preliminary eligibility criteria for a first clinical trial protocol;
4 establishing each of said preliminary eligibility criteria by assigning a condition to a
5 corresponding one of the attributes in said first list, each of said criteria being satisfied only if a
6 patient meets the condition assigned to the corresponding attribute, and each of said criteria
7 being a member of the group consisting of inclusion criteria and exclusion criteria; and
8 defining further eligibility criteria for the first clinical trial protocol, said further eligibility
9 criteria to be applied only to patients who have passed preliminary eligibility for said first
10 protocol as determined by said preliminary eligibility criteria.

1 67. A method according to claim 66, wherein said step of assigning a condition to a
2 corresponding one of the attributes in said first list comprises the step of selecting a value for the
3 attribute from a predetermined set of available values for the attribute.

1 68. A method according to claim 66, wherein said step of assigning a condition to a
2 corresponding one of the attributes in said first list comprises the step of selecting a plurality of
3 acceptable values for the attribute from a predetermined set of available values for the attribute.

1 69. A method according to claim 66, wherein said preliminary eligibility criteria
2 includes a criterion corresponding to each of the attributes in said first list.

1 70. A method according to claim 66, wherein said preliminary eligibility criteria
2 includes at least one inclusion criterion and at least one exclusion criterion.

1 71. A method according to claim 66, further comprising the steps of:
2 establishing each of a plurality of preliminary eligibility criteria for a second clinical trial
3 protocol by assigning a condition to a corresponding one of the attributes in said first list; and
4 defining second further eligibility criteria for the second clinical trial protocol, said second
5 further eligibility criteria to be applied only to patients who have passed preliminary eligibility
6 for said second protocol as determined by said second preliminary eligibility criteria.

1 72. A method according to claim 66, comprising the steps of:
2 selecting, from said plurality of pre-existing lists of patient attributes, a second one of said
3 lists for use in defining second preliminary eligibility criteria for a second clinical trial protocol;
4 establishing each of the criteria in said second preliminary eligibility criteria by assigning
5 a condition to a corresponding one of the attributes in said second list; and
6 defining second further eligibility criteria for the second clinical trial protocol, said second
7 further eligibility criteria to be applied only to patients who have passed preliminary eligibility
8 for said second protocol as determined by said second preliminary eligibility criteria.

1 73. A method according to claim 66, further comprising the step of identifying said
2 further eligibility criteria for the first clinical trial protocol in a first machine-readable protocol
3 definition database in association with said first clinical trial protocol.

1 74. A method according to claim 66, wherein said step of defining further eligibility
2 criteria comprises the step of selecting a term from a predefined controlled medical terminology.

1 75. A method for clinical trials, comprising the steps of:
2 at a first clinical site, obtaining a first subset of patient information items about each of
3 a plurality of patients;

4 comparing the first subset of patient information items about each of said plurality of
5 patients against first eligibility criteria for a first clinical trial for a purpose of determining patient
6 eligibility for said first clinical trial; and

7 transmitting said first subset of patient information items about each of said patients to
8 a central database in conjunction with an identification of said first clinical site.

1 76. A method according to claim 75, further comprising the steps of:
2 obtaining a second subset of patient information items about each of at least a subset of
3 said plurality of patients, after said step of comparing the first subset of patient information items
4 about each of said patients against first eligibility criteria for a first clinical trial for a purpose of
5 determining patient eligibility for said first clinical trial; and

6 comparing the second subset of patient information items about each of said subset of
7 patients against second eligibility criteria for said first clinical trial for a purpose of determining
8 patient eligibility for said first clinical trial.

1 77. A method according to claim 76, further comprising the step of transmitting said
2 second subset of patient information items about each of said subset of patients to said central
3 database.

1 78. A method according to claim 75, further comprising the steps of:
2 obtaining a preliminary subset of information items about each of a group of patients
3 including said plurality of patients; and
4 comparing the preliminary subset of patient information items about each patient in said
5 group of patients against preliminary eligibility criteria for said first clinical trial prior to said step
6 of comparing the first subset of patient information items about each of said plurality of patients
7 against first eligibility criteria.

1 79. A method according to claim 78, further comprising the step of transmitting said
2 preliminary subset of patient information items about each patient in said group of patients to
3 said central database.

1 80. A method according to claim 78, further comprising the step of selecting said
2 plurality of patients in dependence upon said step of comparing the preliminary subset of patient
3 information items.

1 81. A method according to claim 75, wherein said step of transmitting said first subset
2 of patient information items about each of said patients to a central database in conjunction with
3 an identification of said first clinical site consists of the step of transmitting said first subset of
4 patient information items about each of said patients in patient-anonymized form to said central
5 database in conjunction with an identification of said first clinical site.

1 82. A method according to claim 75, wherein at least one of said first eligibility
2 criteria is defined according to a predefined controlled medical terminology.

1 83. A method for clinical trials, comprising the steps of:
2 receiving from a first clinical site a first subset of patient information items about each
3 of a first plurality of patients, the first subset of patient information items having been compared
4 against first eligibility criteria for a first clinical trial for a purpose of determining patient
5 eligibility for said first clinical trial; and
6 recording said first subset of patient information items in a central database.

1 84. A method according to claim 83, further comprising the steps of:

2 receiving from said first clinical site a second subset of patient information items about
3 each of at least a subset of said first plurality of patients, the second subset of patient information
4 items about each of said subset of patients having been compared against second eligibility
5 criteria for said first clinical trial for a purpose of determining patient eligibility for said first
6 clinical trial; and

7 recording said second subset of patient information items in said central database.

1 85. A method according to claim 83, further comprising the steps of:

2 receiving from said first clinical site a preliminary subset of information items about each
3 of a group of patients including said first plurality of patients, the preliminary subset of patient
4 information items about each patient in said group of patients having been compared against
5 preliminary eligibility criteria for said first clinical trial; and

6 recording said preliminary subset of patient information items in said central database.

1 86. A method according to claim 85, wherein said first plurality of patients was
2 selected in dependence upon said preliminary subset of patient information items.

1 87. A method according to claim 83, wherein said step of recording said first subset
2 of patient information items in a central database includes the step of recording said first subset
3 of patient information items in said central database in correspondence with an identity of said
4 first clinical site.

1 88. A method according to claim 83, further comprising the steps of:
2 receiving from a second clinical site, a second subset of patient information items about
3 each of a second plurality of patients, the second subset of patient information items having been
4 compared against said first eligibility criteria for said first clinical trial for a purpose of
5 determining patient eligibility for said first clinical trial; and

6 recording said second subset of patient information items in said central database.

1 89. A method according to claim 88,

2 wherein said step of recording said first subset of patient information items in a central
3 database includes the step of recording said first subset of patient information items in said
4 central database in correspondence with an identity of said first clinical site

5 and wherein said step of recording said second subset of patient information items in said
6 central database includes the step of recording said second subset of patient information items
7 in said central database in correspondence with an identity of said second clinical site.

1 90. A method according to claim 89, further comprising the step of querying said
2 central database to simulate clinical site-specific patient accrual in dependence upon eligibility
3 criteria for patients to be included in clinical trials of a particular clinical trial protocol.

1 91. A method according to claim 90, wherein said particular clinical trial protocol is
2 different from said first clinical trial protocol.

1 92. A method according to claim 88, further comprising the steps of:
2 receiving from a clinical site, a third subset of patient information items about each of a
3 third plurality of patients, the third subset of patient information items having been compared
4 against said first eligibility criteria for a second clinical trial for a purpose of determining patient
5 eligibility for said second clinical trial; and
6 recording said third subset of patient information items in said central database.

1 93. A method according to claim 92,

2 wherein said step of recording said first subset of patient information items in a central
3 database includes the step of recording said first subset of patient information items in said
4 central database in correspondence with an identity of said first clinical site,

5 wherein said step of recording said second subset of patient information items in said
6 central database includes the step of recording said second subset of patient information items
7 in said central database in correspondence with an identity of said second clinical site,

8 and wherein said step of recording said third subset of patient information items in a
9 central database includes the step of recording said third subset of patient information items in
10 said central database in correspondence with an identity of the clinical site from which said third
11 subset of patient information was received.

1 94. A method according to claim 93, further comprising the step of querying said
2 central database to simulate clinical site-specific patient accrual in dependence upon eligibility
3 criteria for patients to be included in clinical trials of a particular clinical trial protocol.

1 95. A method according to claim 94, wherein said particular clinical trial protocol is
2 different from both said first and second clinical trial protocols.

1 96. A method according to claim 83, wherein at least one of said first eligibility
2 criteria is defined according to a predefined controlled medical terminology.

1 97. A clinical trials method, comprising the steps of:
2 managing progress of a first plurality of patients in a first clinical trial according to a first
3 predefined workflow graph formed as part of a first clinical trial protocol;
4 recording the progress of each of the patients in said first plurality of patients through
5 said first workflow graph; and

6 transmitting the recorded progress of each of the patients in said first plurality of patients
7 to a central database.

1 98. A method according to claim 97, further comprising the steps of:
2 managing progress of a second plurality of patients in a second clinical trial according to
3 a second predefined workflow graph formed as part of a second clinical trial protocol different
4 from said first clinical trial protocol;
5 recording the progress of each of the patients in said second plurality of patients through
6 said second workflow graph; and
7 transmitting the recorded progress of each of the patients in said second plurality of
8 patients to said central database.

1 99. A method according to claim 97, wherein said first workflow graph connects a
2 first plurality of workflow tasks,
3 and wherein said step of transmitting the recorded progress of each of the patients in said
4 first plurality of patients to a central database comprises the step of transmitting to said central
5 database an indication of which of workflow tasks have been performed on each of the patients
6 in said first plurality of patients.

1 100. A method according to claim 99, wherein said step of transmitting the recorded
2 progress of each of the patients in said first plurality of patients to a central database further
3 comprises the step of transmitting to said central database patient medical status information
4 collected from observation of each of the patients in said first plurality of patients.

1 101. A method according to claim 97, wherein said step of transmitting the recorded
2 progress of each of the patients in said first plurality of patients to a central database comprises

3 the step of transmitting to said central database patient medical status information collected from
4 observation of each of the patients in said first plurality of patients.

1 102. A method according to claim 101, wherein said patient medical status information
2 includes at least one information item defined according to a predefined controlled medical
3 terminology,

4 receiving from each of said sites information items about each of a respective plurality
5 of patients, each of said information items being relevant to one or more of said patient eligibility
6 criteria; and

7 storing said information items in a database.

1 103. A clinical trials method, comprising the steps of:

2 receiving from a first clinical site first notifications of progress of each of a first plurality
3 of patients through a first predefined workflow graph formed as part of a first clinical trial and
4 recording said first notifications in a database; and

5 receiving from said first clinical site second notifications of progress of each of a second
6 plurality of patients through a second predefined workflow graph formed as part of a second
7 clinical trial and recording said second notifications in said database.

1 104. A method according to claim 103, wherein said first workflow graph connects
2 a first plurality of workflow tasks,

3 and wherein said first notifications of progress of each of a first plurality of patients
4 through a first predefined workflow graph include indications of which of workflow tasks have
5 been performed on each of the patients in said first plurality of patients.

1 105. A method according to claim 104, wherein said first notifications of progress
2 further include patient medical status information collected from observation of patients in said
3 first plurality of patients.

1 106. A method according to claim 105, wherein said patient medical status information
2 includes at least one information item defined according to a predefined controlled medical
3 terminology.

1 107. A method according to claim 103, further comprising the steps of:
2 receiving from a second clinical site third notifications of progress of each of a third
3 plurality of patients through said first predefined workflow graph formed as part of said first
4 clinical trial and recording said third notifications in said database.

1 108. A method according to claim 107, further comprising the step of evaluating the
2 progress notifications received from at least said first and second clinical sites for a purpose of
3 developing a metric comparing relative clinical trial performance of at least said first and second
4 sites.

1 109. A method according to claim 103, further comprising the step of evaluating the
2 progress notifications received from at least said first clinical site for a purpose of developing a
3 metric of clinical trial performance of said first site.

1 110. A clinical trials method, comprising the steps of:
2 storing in a library of clinical trial sub-protocol components, a first clinical trial sub-
3 protocol component identifying at least one member of the group consisting of a patient
4 eligibility criterion and a protocol workflow task; and

5 assigning a first sub-protocol component level user access control to said first clinical trial
6 sub-protocol component in said library.

1 111. A method according to claim 110, comprising the step of storing a plurality of
2 databases each identifying, for a respective clinical trial protocol, at least one member of the
3 group consisting of patient eligibility criteria and protocol workflow tasks,
4 wherein said step of storing a plurality of databases includes said step of storing a first
5 clinical trial sub-protocol component.

1 112. A method according to claim 111, further comprising the step of providing access
2 to individual ones of said databases by each of a plurality of clinical sites in accordance with
3 predetermined site eligibility criteria.

1 113. A method according to claim 110, wherein said step of assigning a first sub-
2 protocol component level user access control to said first clinical trial sub-protocol component
3 in said library comprises the steps of:
4 providing read/write access to said first clinical trial sub-protocol component by a first
5 user; and
6 providing read but not write access to said said first clinical trial sub-protocol component
7 by a second user.

1 114. A method according to claim 110, wherein said first clinical trial sub-protocol
2 component includes first and second sub-protocol sub-components.

1 115. A method according to claim 114, further comprising the steps of:
2 assigning a first sub-protocol sub-component level user access control to said first sub-
3 protocol sub-component; and

4 assigning a second sub-protocol sub-component level user access control to said second
5 clinical trials sub-protocol sub-component in said library.

1 116. A method according to claim 110, further comprising the steps of:
2 storing in said library a second clinical trial sub-protocol component identifying at least
3 one member of the group consisting of a patient eligibility criterion and a protocol workflow
4 task; and
5 assigning a second sub-protocol component level user access control to said second
6 clinical trial sub-protocol component in said library.

1 117. A method according to claim 116, wherein said first and second clinical trial sub-
2 protocol components are both components of a common clinical trial protocol.

1 118. A method according to claim 116, wherein said first and second clinical trial sub-
2 protocol components are components of different clinical trial protocols.

1 119. A method according to claim 116, wherein said step of assigning a first sub-
2 protocol component level user access control to said first clinical trial sub-protocol component
3 in said library comprises the step of providing read/write access to said first clinical trial sub-
4 protocol component by a first user,
5 and wherein said step of assigning a second sub-protocol component level user access
6 control to said second clinical trial sub-protocol component in said library comprises the step of
7 providing read but not write access to said said second clinical trial sub-protocol component by
8 said first user.

1 120. A clinical trials method, comprising the steps of:

2 storing a plurality of clinical trial sub-protocol components each identifying at least one
3 member of the group consisting of a patient eligibility criterion and a protocol workflow task;
4 and
5 providing access to individual ones of said clinical trial sub-protocol components by each
6 of a plurality of users in accordance with predetermined sub-protocol component level access
7 controls.

1 121. A method according to claim 120, comprising the step of storing a plurality of
2 databases each identifying, for a respective clinical trial protocol, at least one member of the
3 group consisting of patient eligibility criteria and protocol workflow tasks,
4 wherein said step of storing a plurality of databases includes said step of storing a
5 plurality of clinical trial sub-protocol components.

1 122. A method according to claim 121, further comprising the step of providing access
2 to individual ones of said databases by each of a plurality of clinical sites in accordance with
3 predetermined site eligibility criteria.

1 123. A method according to claim 120, wherein said step of providing access to
2 individual ones of said clinical trial sub-protocol components by each of a plurality of users
3 comprises the steps of:
4 providing read/write access to a first one of said clinical trial sub-protocol components
5 by a first one of said users; and
6 providing read but not write access to said first clinical trial sub-protocol component by
7 a second one of said users.

1 124. A method according to claim 123, wherein said step of providing access to
2 individual ones of said clinical trial sub-protocol components by each of a plurality of users
3 further comprises the steps of:

4 providing read/write access to a second one of said clinical trial sub-protocol components
5 by said second user.

1 125. A method according to claim 120, wherein a first one of said sub-protocol
2 components includes first and second sub-protocol sub-components.

1 126. A method according to claim 125, further comprising the step of providing access
2 to said clinical trials sub-protocol sub-components by each of a plurality of users in accordance
3 with predetermined sub-protocol sub-component level access controls.

1 127. A method according to claim 120, further comprising the step of receiving said
2 sub-protocol components from a plurality of different protocol designers.

1 128. At least one computer readable medium collectively carrying a library identifying
2 a plurality of clinical trial sub-protocol components each identifying at least one member of the
3 group consisting of patient eligibility criteria and protocol workflow tasks, said library further
4 identifying sub-protocol component level user access controls for at least a subset of said sub-
5 protocol components.

1 129. A medium according to claim 128, wherein said library further identifies a
2 plurality of protocol databases each identifying, for a respective clinical trial protocol, at least
3 one member of the group consisting of patient eligibility criteria and protocol workflow tasks,
4 wherein one of said clinical trial sub-protocol components is a component of one of said
5 clinical trial protocols.

1 130. A medium according to claim 129, wherein said library further identifies protocol-
2 level access controls which control access to individual ones of said databases by each of a
3 plurality of clinical sites.

1 131. A medium according to claim 128, wherein said sub-protocol component level
2 user access controls include a first control which provides read/write access to a first one of said
3 clinical trial sub-protocol components by a first user and which further provides read but not
4 write access to said first clinical trial sub-protocol component by a second user.

1 132. A medium according to claim 131, wherein said sub-protocol component level
2 user access controls further include a third control which provides read/write access to a second
3 one of said clinical trial sub-protocol components by said second user.

1 133. A medium according to claim 128, wherein a first one of said sub-protocol
2 components includes first and second sub-protocol sub-components.

1 134. A medium according to claim 133, wherein said sub-protocol component level
2 user access controls further include sub-protocol sub-component level user access controls.

1 135. A medium according to claim 128, wherein first and second ones of said sub-
2 protocol components were prepared by different protocol designers.

1 136. A method according to claim 128, wherein first and second ones of said sub-
2 protocol components are both components of a common clinical trial protocol.

1 137. A method according to claim 128, wherein first and second ones of said sub-
2 protocol components are components of first and second different clinical trial protocols.

1 138. A medium according to claim 137, wherein said first and second clinical trial
2 protocols address different disease categories.

137. A method according to claim 128, wherein first and second ones of said sub-
protocol components are components of first and second different clinical trial protocols.

ABSTRACT

Clinical trials are defined, managed and evaluated according to an overall end-to-end system. The central authority creates protocol meta-models and makes them available to clinical trial protocol designers. Each meta-model includes a short list of preliminary patient eligibility attributes which are appropriate for a particular disease category. The protocol designer chooses the appropriate meta-model, and encodes the clinical trial protocol, including eligibility and patient workflow, within the selected meta-model. The resulting protocol database is stored together with databases of other protocols in a library of protocol databases. Sponsors and individual clinical sites have controlled access to the protocols. Study sites make reference to the pertinent protocol databases to which they have access in the protocol database library in order to perform patient eligibility screening. Once a patient is enrolled into a study, the protocol database indicates to the clinician what tasks are to be performed at each patient visit. These tasks can include both patient management tasks and data management tasks. The workflow graph advantageously also instructs the proper time for the clinician to obtain a patient's informed consent. The system reports patient progress to study sponsors, who can then monitor the progress of the trial, and to a central authority which can then generate performance metrics. Advantageously, a common controlled medical terminology database is used by all components of the system.

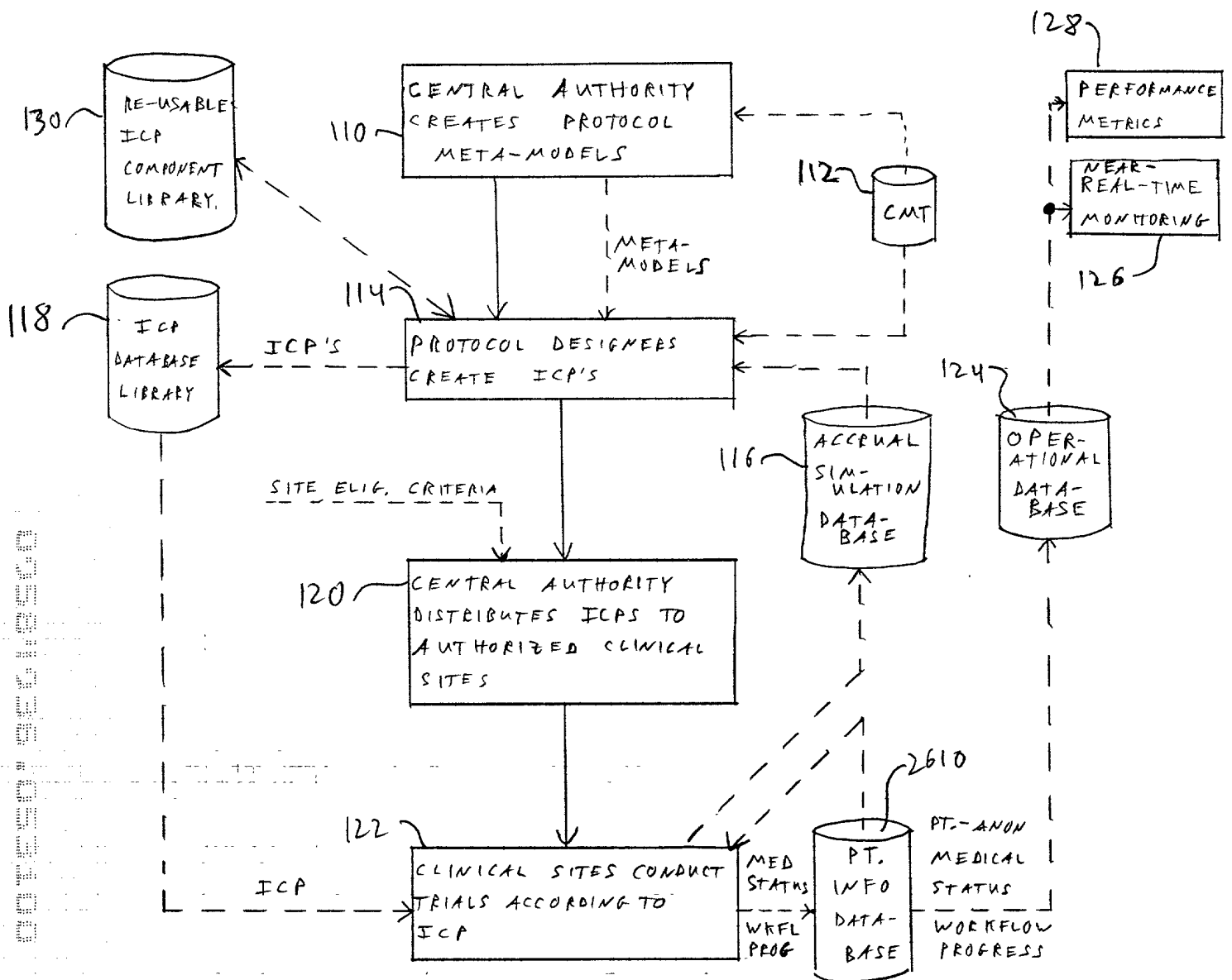


Fig. 1

cancer_protocols_INSTANCE_00039 (Instance of Cancer_Clinical_Protocol)			
Label	CALGB 49802	Version	mgk 25Jan00
Title	Phase III Study of Adriamycin/Taxotere vs Adriamycin/Cytosan for the Adjuvant treatment of Node Positive or High Risk Node Negative Breast Cancer		
Authors	M. G. Public		
Reference	MUSC PRN web page		
Clinical Algorithm	CALGB 49802 Level 1		
Context Reference			
Entry Criteria (1 values)			
Protocol Name	CALGB 49802		
Clinical State Name			
Exclusion List	<p>Tumor of any size with direct extension to chest wall or skin (T4)</p> <p>Patient is pregnant or nursing</p> <p style="text-align: right;">212</p>		
Inclusion List	<p>Histologically or cytologically confirmed invasive breast cancer</p> <p>1-3 histologically involved axillary lymph nodes</p> <p>No evidence of metastatic disease (M0)</p> <p>Absolute neutrophil count at least 1,500/mm³</p> <p>Platelet count at least 100,000/mm³</p> <p>Left ventricular ejection fraction at rest at least 45% by MUGA</p> <p>Bilirubin no greater than 1.2 times upper limit of normal (ULN)</p> <p>Age 18 - 70</p> <p>Effective contraception required of fertile women</p> <p>No prior chemotherapy</p> <p>No prior radiotherapy</p> <p>No concurrent estrogen therapy</p> <p style="text-align: right;">210</p>		

Fig. 2

344-346

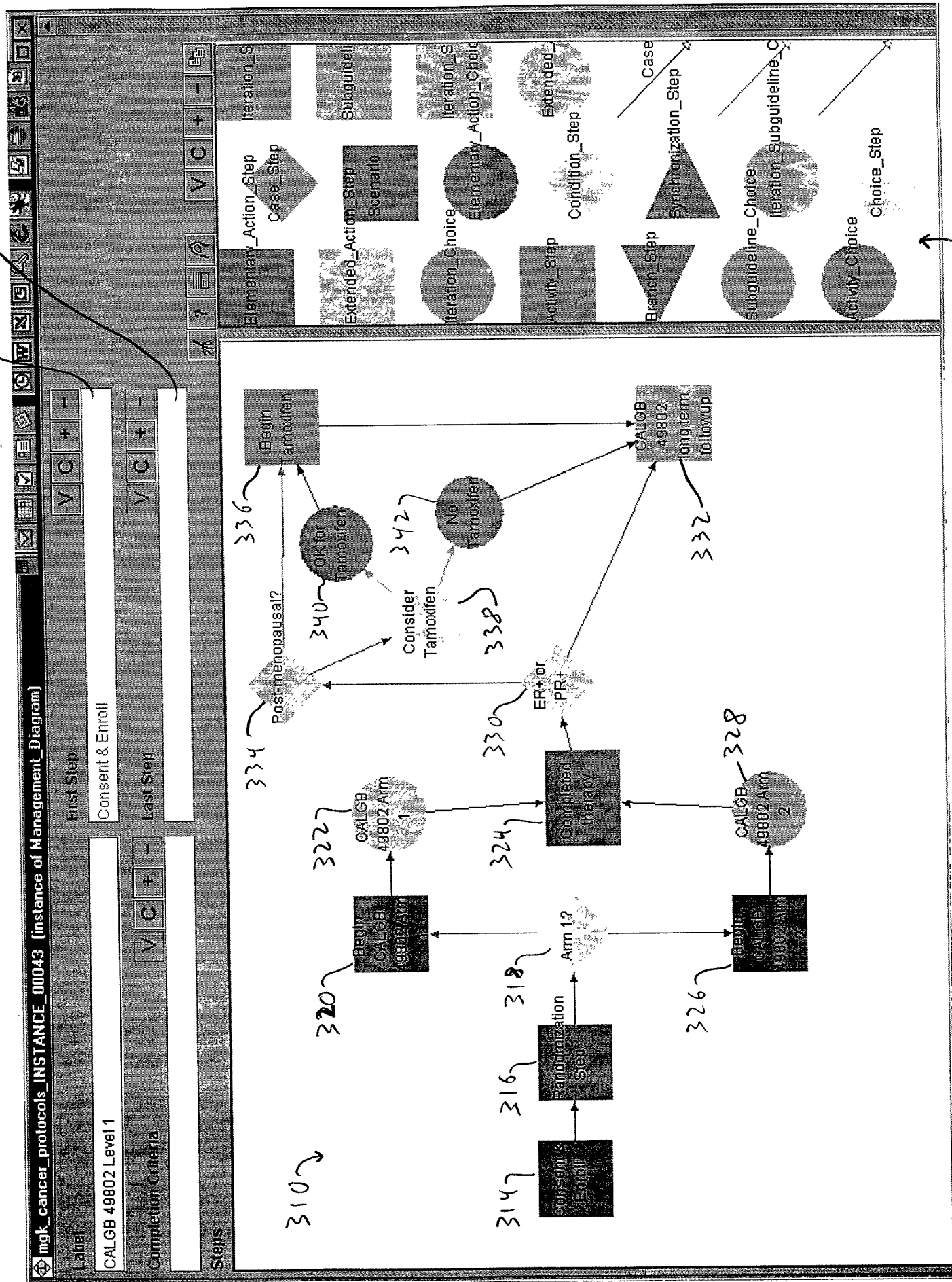


Fig. 3

mgk_cancer_protocols_INSTANCE_00063 (instance of Consultation_Act...)		mgk_cancer_protocols_INSTANCE_00063 (instance of Consultation_Act...)	
Label	mgk_cancer_protocols_INSTANCE_00063 (instance of Consultation_Act...)		
CALGB 49802: Collect Stratification Variable	mgk_cancer_protocols_INSTANCE_00063 (instance of Consultation_Act...)		
Followed By	V C + -	Evaluate lymph node status Evaluate menopausal status Evaluate estrogen receptor status Evaluate progesterone receptor status	V C + -
Rule In	V C + -	References	
Rule Out	V C + -		

Fig. 5

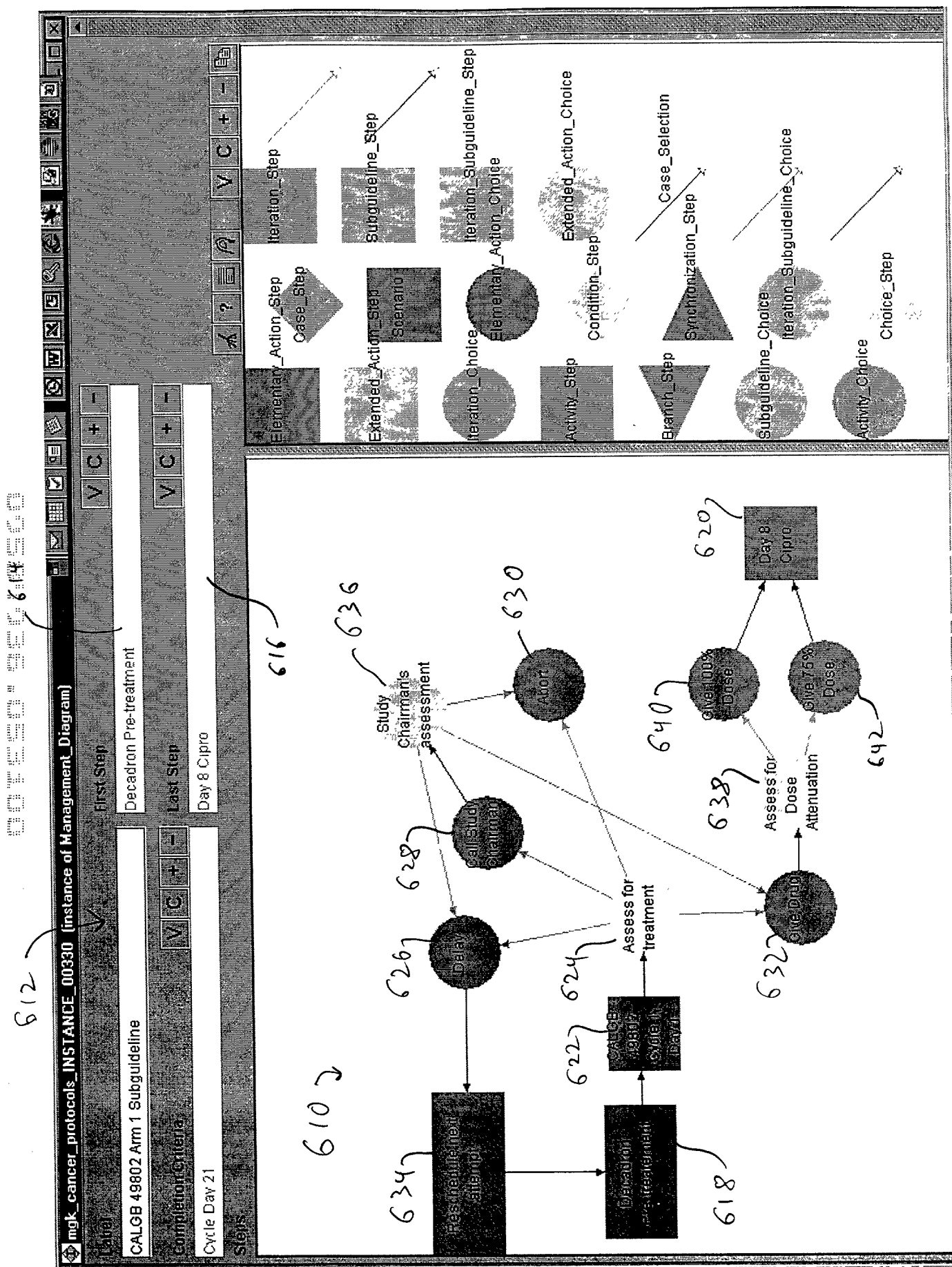


Fig. 6

710

724

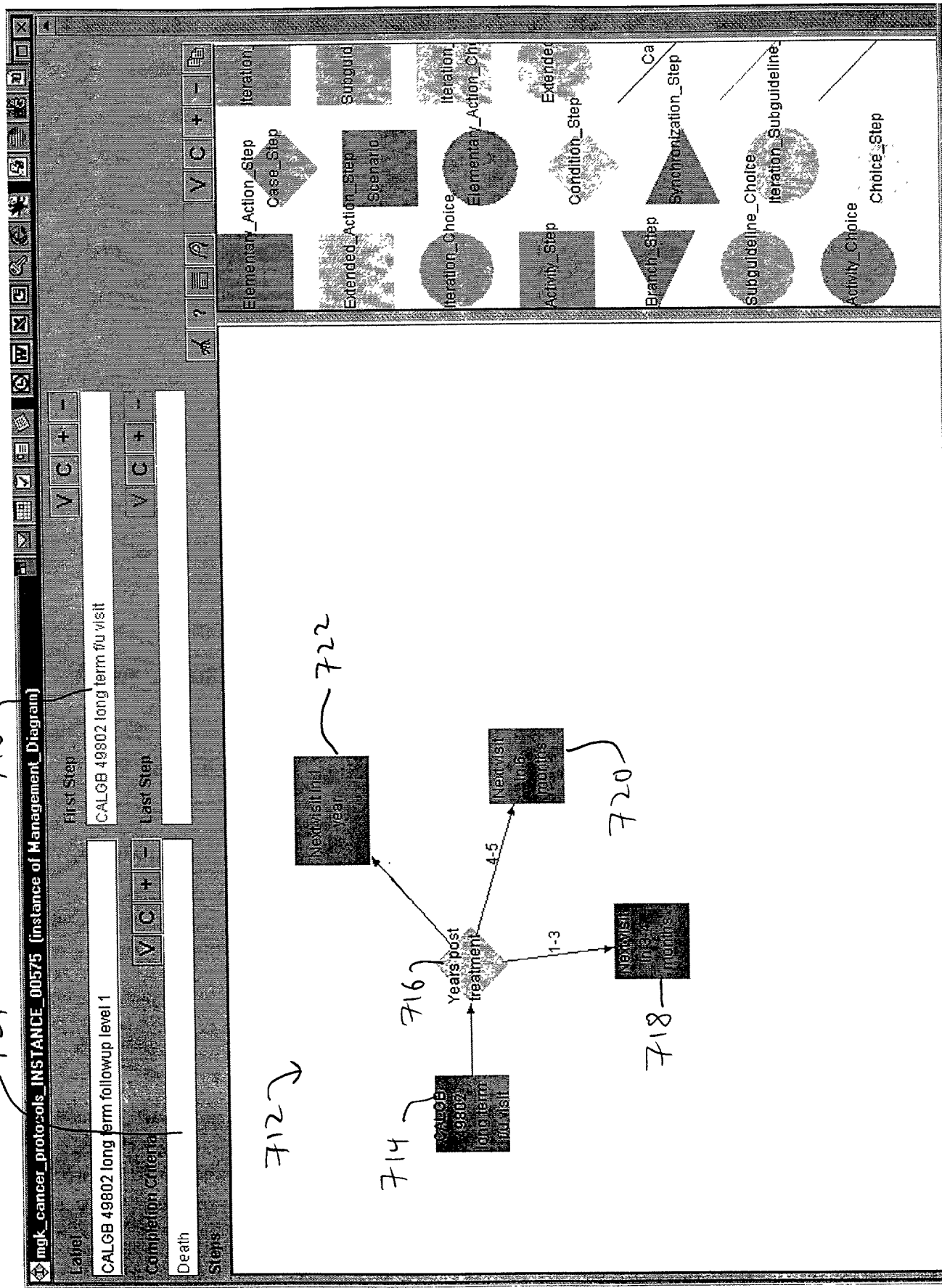


Fig. 7

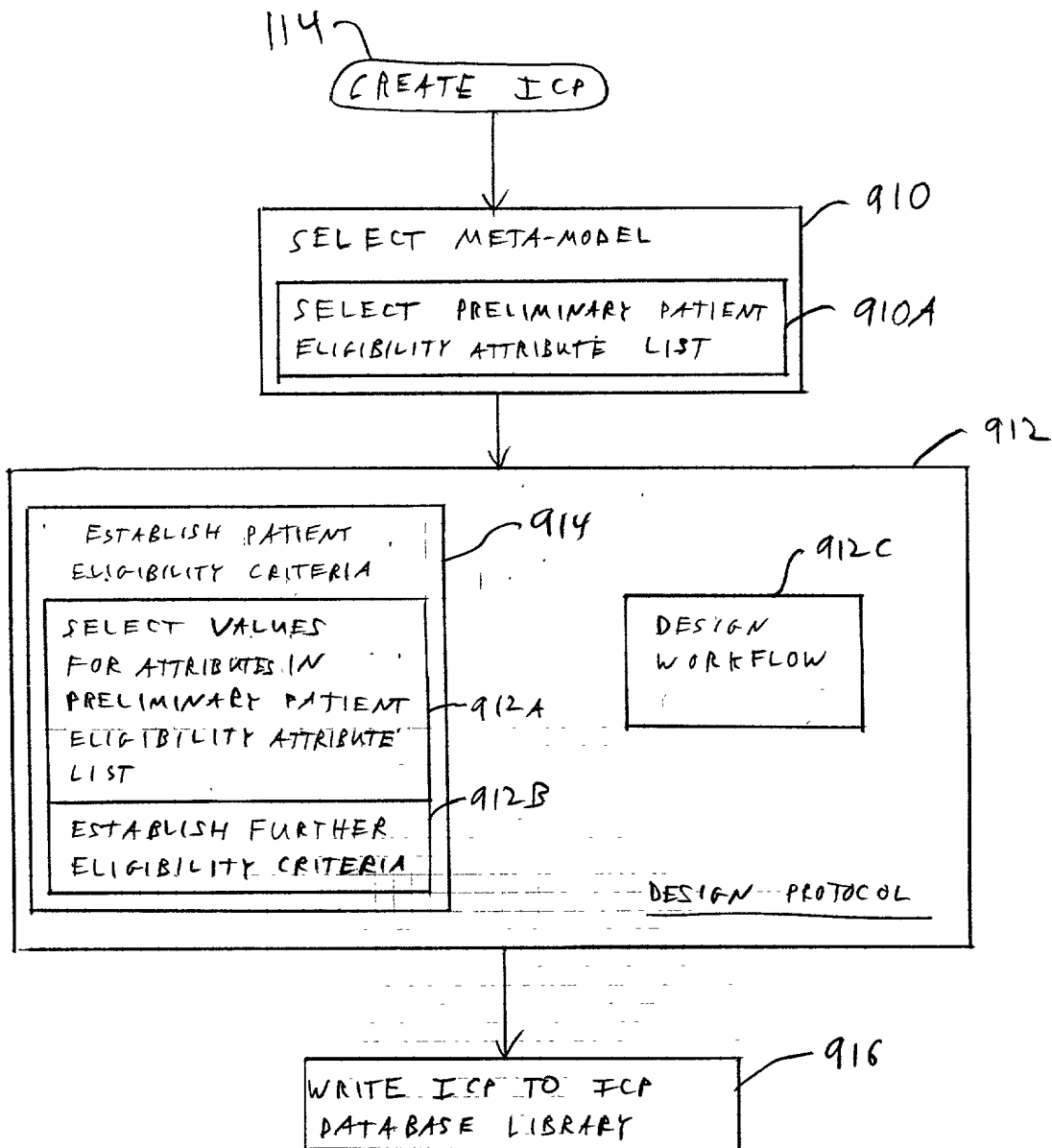


Fig. 1

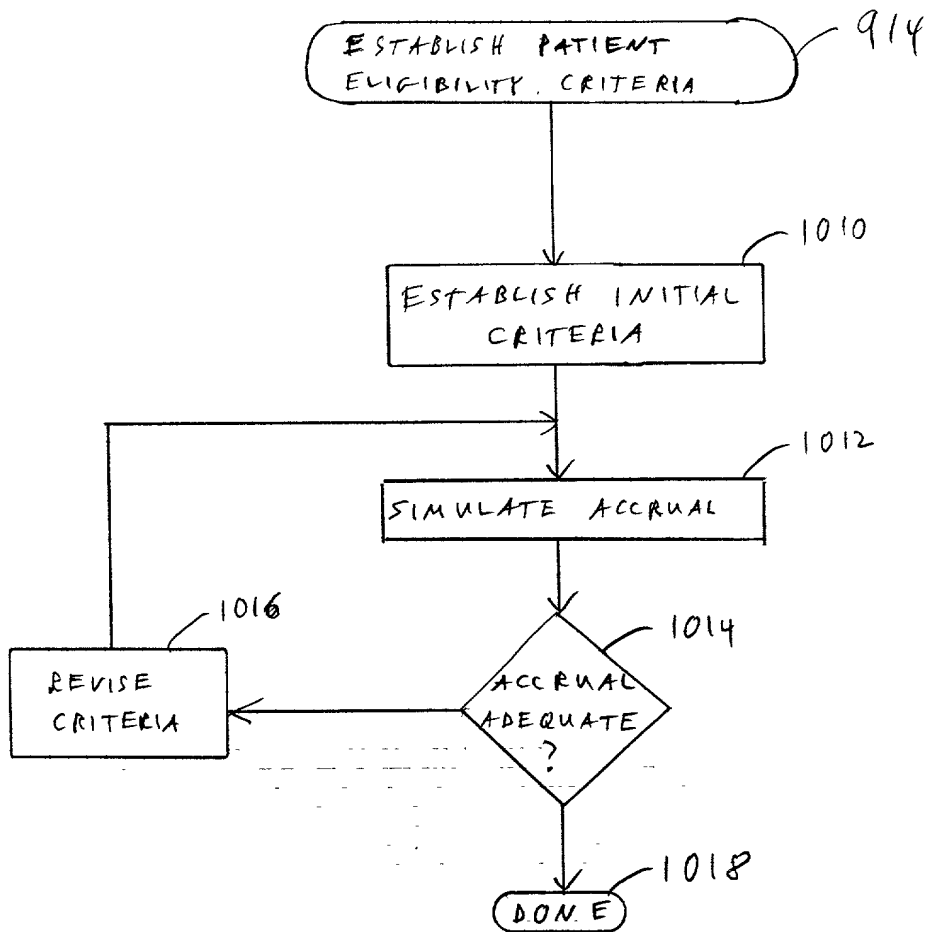


Fig. 10

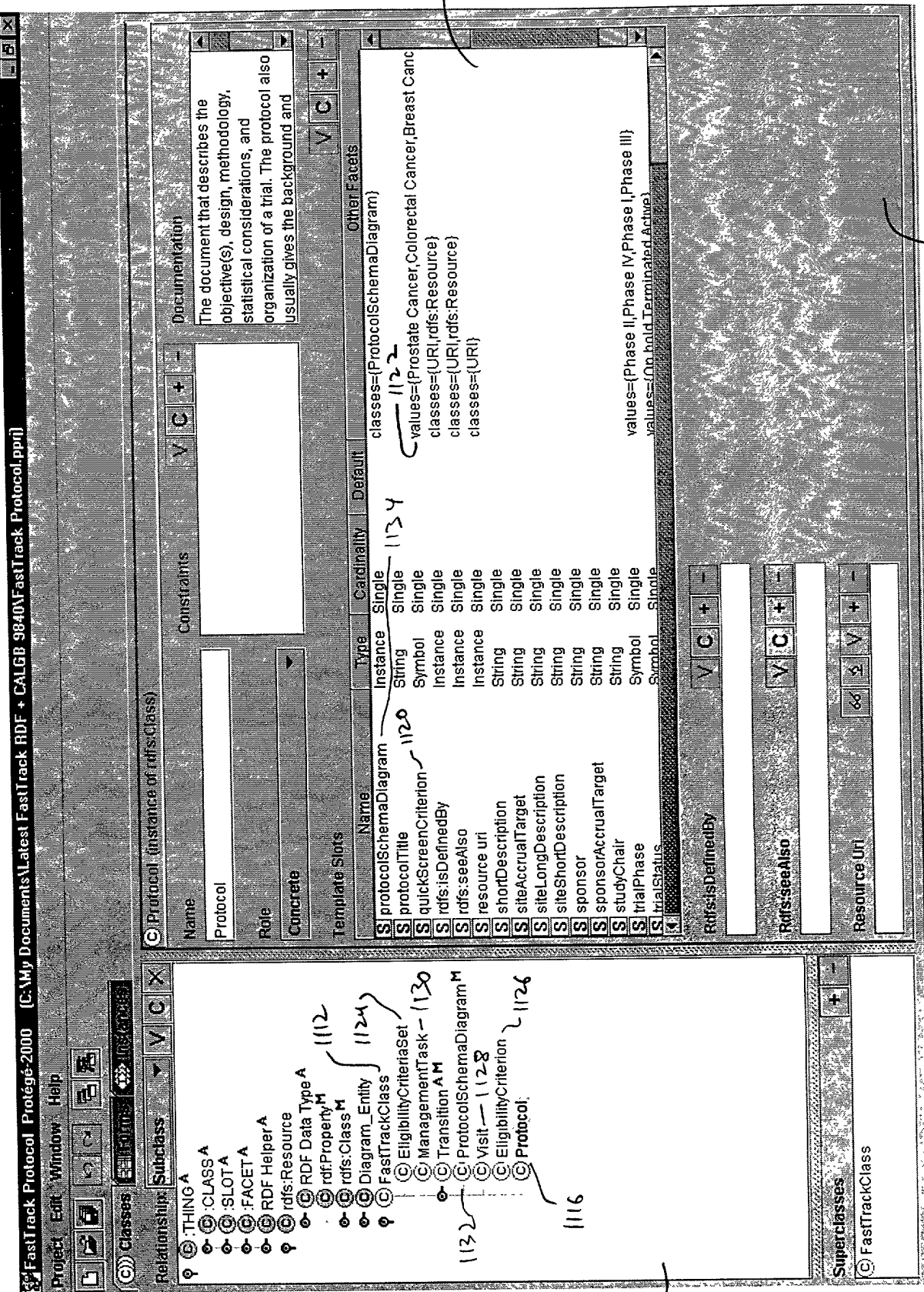


Fig. 11

FastTrack Protocol_INSTANCE_00212 [instance of Protocol]	
ProtocolTitle	Version
A Phase III Study of Paclitaxel via Weekly 1-Hour Infusion w	Update #1
ProtocolIdentifier	VersionDate
CALGB 9840	December 15, 1998
OfficialSourceDocument	EligibilityCriteriaSet
http://prn.musc.edu/research/protocol/deptmed/divhcn/cbr	V C + -
ShortDescription	EligibilityCriteria
CALGB 9840	CALGB 9840 Eligibility Criteria
StudyChair	
Andrew D. Seidman, M.D.	
Sponsor	LongDescription
CALGB	
QuickScreenCriterion	
Breast Cancer	
ProtocolObjectives	
To compare "standard" (S) paclitaxel at 175 mg/m ² via 3-hour infusion every 3 weeks to "dose-dense" (DD) paclitaxel at 80 mg/m ² via 1-hour infusion every week	
TrialStatus	FirstVisit
Active	V C + -
AccrualStatus	Screening Visit
Open for accrual	
TrialPhase	ProtocolSchemaDiagram
Phase III	V C + -
TrialType	CALGB 9840 Schema
Cooperative-group	

1210

1214

Fig. 12

Fig. 13

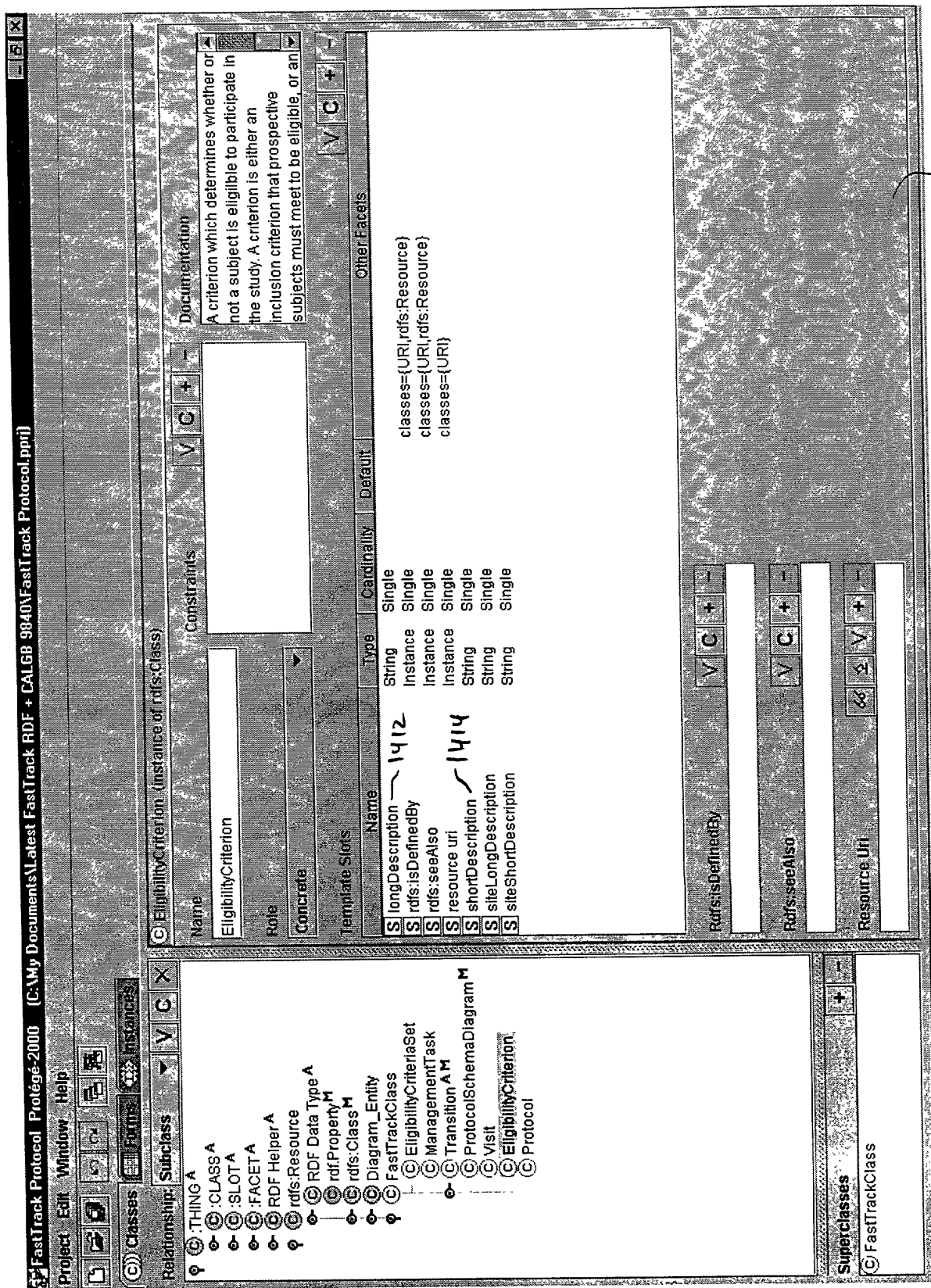


Fig. 14

1410

FastTrack Protocol_INSTANCE_00074 [instance of EligibilityCriteriaSet]	
ShortDescription	LongDescription
CALGB 9840 Eligibility Criteria	
InclusionCriteria	
<ul style="list-style-type: none"> Female Breast adenocarcinoma that is inoperable, recurrent, or metastatic More than 4 weeks since last chemotherapy More than 6 weeks since treatment with nitrosureas, melphalan, or More than 4 weeks since last hormonal therapy OR tumor measur Age >= 18 Measurable disease Granulocytes >= 1,500 / ul Platelet count >= 100,000 / ul Creatinine <= 2.0 mg/dl Bilirubin within institutional normal limits SGOT (AST) <= 3X upper limits of normal Greater than 2 weeks from prior surgery 	
ExclusionCriteria	
<ul style="list-style-type: none"> More than 1 prior chemotherapy regimens for metastatic or locally CNS metastases if untreated or symptomatic ~ 1510 Prior taxane for metastatic or locally-advanced breast cancer Prior taxane in adjuvant setting where patient remained disease fr Leptomeningeal carcinoma 	
SiteLongDescription	
SiteShortDescription	
Refs:isDefinedBy	
Refs:seeAlso	
Resource Uri	

Fig. 15

FastTrack Protocol_INSTANCE_00073 (Instance of EligibilityCriterion)	
ShortDescription	
LongDescription	
SiteLongDescription	
SiteShortDescription	

1610 →

1612 →

Fig. 16

FastTrack Protocol Protégé-2000 [C:\My Documents\Latest FastTrack RDF + CALGB 9840\FastTrack Protocol.ppt]

Project Edit Window Help

Classes

Forms

Instances

Relationship: Subclass

THING A

CLASS A

SLOT A

FACET A

RDF Helper A

rdfs:Resource

RDF Data Type A

rdt:Property M

rdfs:Class M

Diagram Entity

FastTrackClass

EligibilityCriteriaSet

ManagementTask

Transition A M

ProtocolSchemaDiagram M

Visit

EligibilityCriterion

Protocol

Superclasses

FastTrackClass

Visit (instance of rdfs:Class)

Name

Visit

Role

Concrete

Constraints

Documentation

An actual encounter between the provider and a patient on study. A number of possible visits are associated with a study (Protocol)

Template Slots

Name	Type	Cardinality	Default	Other Facets
dataManagementTasks	Instance	Multiple		classes={ManagementTask}
longDescription	String	Single		classes={ManagementTask}
patientManagementTasks	Instance	Multiple		classes={VisitToVisitTransition}
possibleVisitTransitions	Instance	Multiple		classes={URI,rdfs:Resource}
rdfs:isDefinedBy	Instance	Single		classes={URI,rdfs:Resource}
rdfs:seeAlso	Instance	Single		classes={URI}
resource uri	String	Single		
shortDescription	String	Single		
siteLongDescription	String	Single		
siteShortDescription	String	Single		

Rdfs:isDefinedBy

Rdfs:seeAlso

Resource Uri

Fig. 17

1710

FastTrack Protocol_INSTANCE_00014 (Instance of Visit)	
ShortDescription Arm A Treatment Visit	PossibleVisitTransitions Arm A Treatment to Arm A Treatment Retry #1 Arm A Treatment to Long Term Followup Arm A Treatment Visit to Arm A Treatment Visit
DataManagementTasks Submit Form C-116 Submit Form C-118 Submit Form C-080 Submit Form C-344 + Form C-080 (*) Submit Form C-344 + Form C-272 (*) Submit Form C-113 (*) Submit Form C-260 (*) Submit Form C-300 (*)	PatientManagementTasks Confirm granulocytes >= 1500 /ul Confirm no G-CSF given in past 24 hours Give Dexmethosone 10 mg IV, 30 minutes Give Diphenhydramine 50 mg IV, 30 minutes Give Cimetidine 300 mg IV, 30 minutes Give anti-emetics (*) Give Arm A Pacitaxel treatment Give G-CSF (*) Evaluate Patient Response Schedule next visit
LongDescription Arm A of the CALG 9840 consists of treatment with Pacitaxel 175 mg/m2 administered as a 3 hour infusion intravenously every three weeks. One cycle is equivalent to one infusion. Treatment cycles will be repeated every 21 days as long as the patient has stable or responding disease. Granulocyte count must be >= 1500/ul and platelet count must be >= 100,000 / ul on day 1 of each cycle. Patients should receive a minimum of two cycles of therapy, unless there is rapid disease progression (>50% increase in product of bi-dimensional measurements).	
SiteLongDescription	
SiteShortDescription	

$$\begin{array}{r} 18 \\ 5 \overline{) 90} \end{array}$$

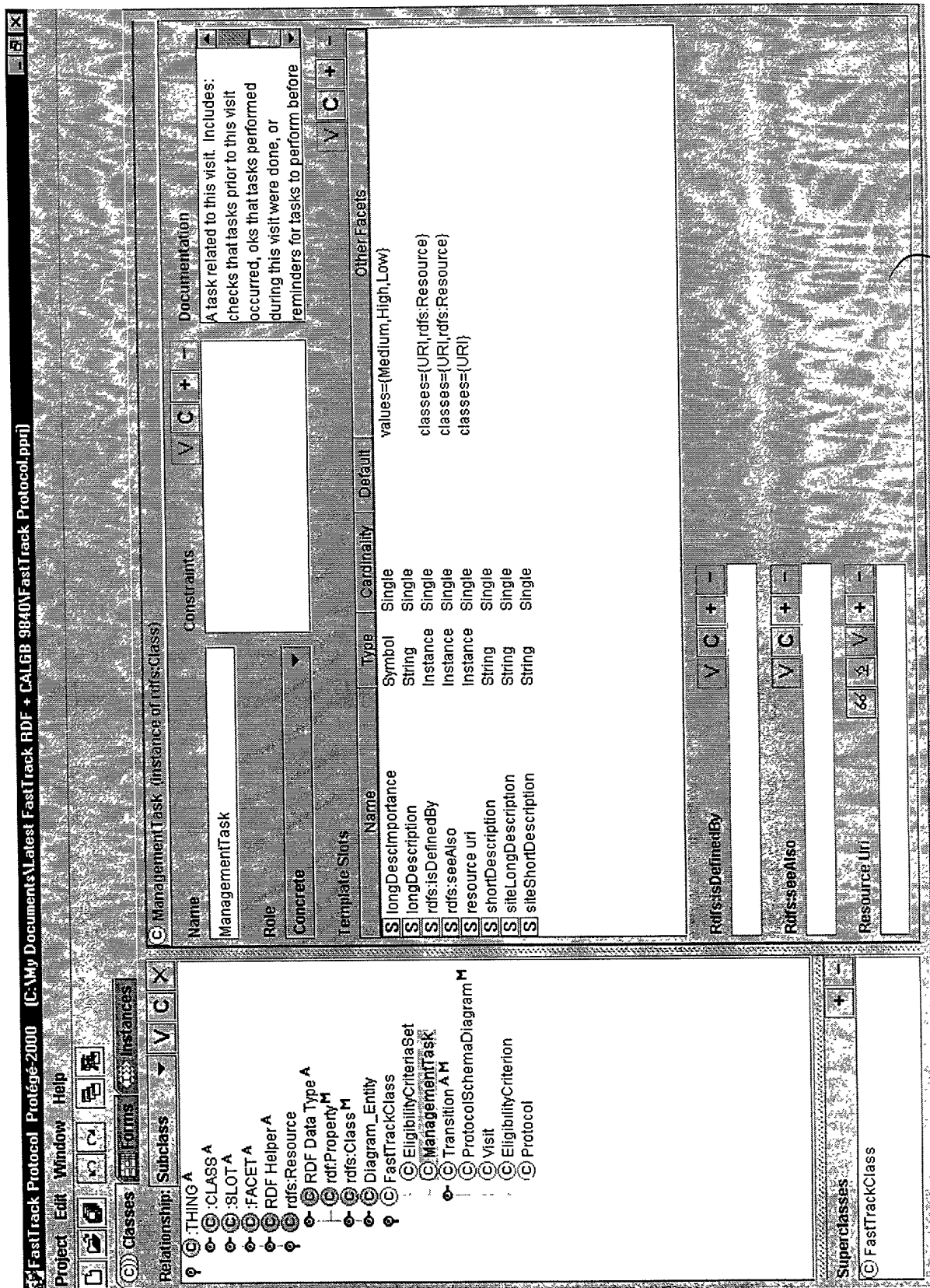


Fig. 19

FastTrack Protocol_INSTANCE_00206 (Instance of ManagementTask)

ShortDescription

Give Arm A Paclitaxel treatment

LongDescription

Give Paclitaxel 175 mg/m² IV, 3 hours. This treatment is given to patients in Arm A of the CALGB 9840 protocol. It is given once every 3 weeks. One cycle is equivalent to one infusion. Granulocyte count must be $\geq 1500/\mu\text{l}$ and platelet count must be $\geq 100,000/\mu\text{l}$ on day 1 of each cycle in order to proceed with the Paclitaxel infusion. Patients must receive the pre-medication prior to Paclitaxel infusion. If either the granulocyte or platelet count are not adequate, do not continue with treatment. Patients should receive a minimum of 2 cycles unless there is rapid disease progression.

Expected toxicities:

The dose-limiting toxicity of Paclitaxel is neutropenia. Other known toxicities include nausea and vomiting, diarrhea, stomatitis, mucositis, pharyngitis, typhilitis, ischemic colitis, bradycardia, atrial arrhythmia, hypotension, sensory (taste), peripheral neuropathy, seizures, mood, hepatic encephalopathy, acute anaphylactoid and urticarial reactions, flushing, rash, pruritis, increased SGOT, SGPT, bilirubin and/or alkaline phosphatase, hepatic failure, alopecia, fatigue, arthralgia, myalgia, light-headedness, myopathy, visual changes (sensation of flashing lights, blurred vision). Local infiltration with Paclitaxel will cause mild local symptoms (erythema, discomfort, induration) that usually resolve within a week. If infiltration occurs, there is the rare possibility of ulceration or rash. Seizure have been reported rarely in association with Paclitaxel use.

Dose Modifications:

Allergic Reactions: Patients with grade 1 or 2 allergic reactions may have treatment continued without modifications. Patients with grade 3 or 4 allergic reactions who are responding to treatment may remain on protocol therapy after discussion with Study Chair. Such patients are at risk for recurrent allergic reactions. As a first maneuver, retreatment after premedication with oral recurrent allergic reactions. As a first maneuver, retreatment after premedication with oral dexamethasone 20 mg at 12 and 6 hours pre-administration of Paclitaxel, along with IV H1 and H2-receptor antagonist should be attempted. If necessary, thereafter, infusion rate adjustments will be considered and additional premedications will be administered. These patients must be informed of the potential risks of recurrent allergic reactions and must be carefully monitored.

Hematologic Toxicity: Patients are to be managed as clinically indicated. Colony stimulation factors (G-CSF) should be used in the manner described below. Exceptions should be discussed with the Study Chair.

Site LongDescription

Fig. 20

FastTrack Protocol_INSTANCE_00196 (Instance of ManagementTask)	
ShortDescription	Submit Form C-116
LongDescription	Submit CALGB Advanced Breast Cancer Followup-form (C-116) every two cycles while on protocol therapy, at 6 & 12 months after end of treatment, at disease progression or initiation of non-protocol therapy.
SiteLongDescription	
SiteShortDescription	

Fig. 21

[illegible]

Fig. 22

2212

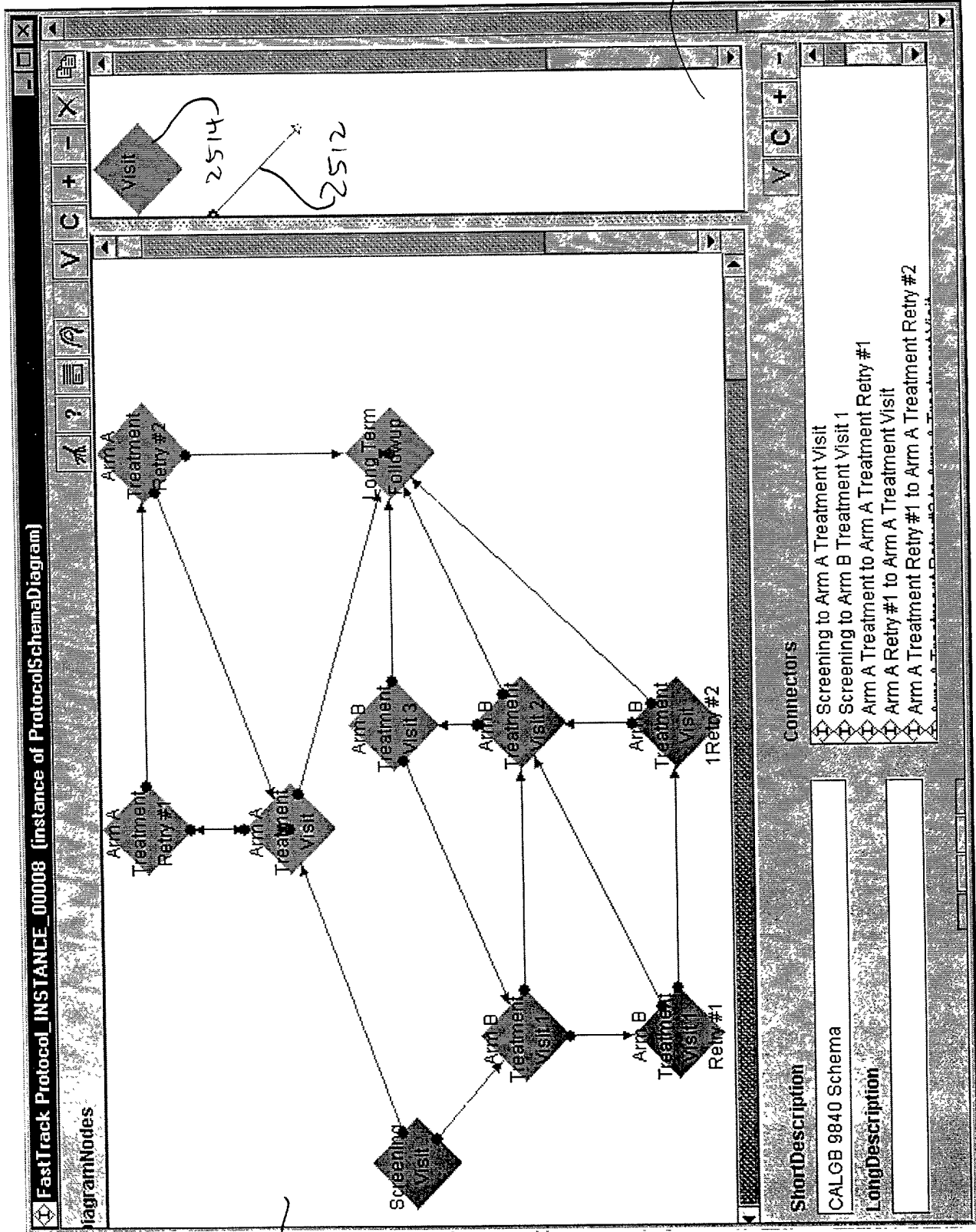


Fig. 25

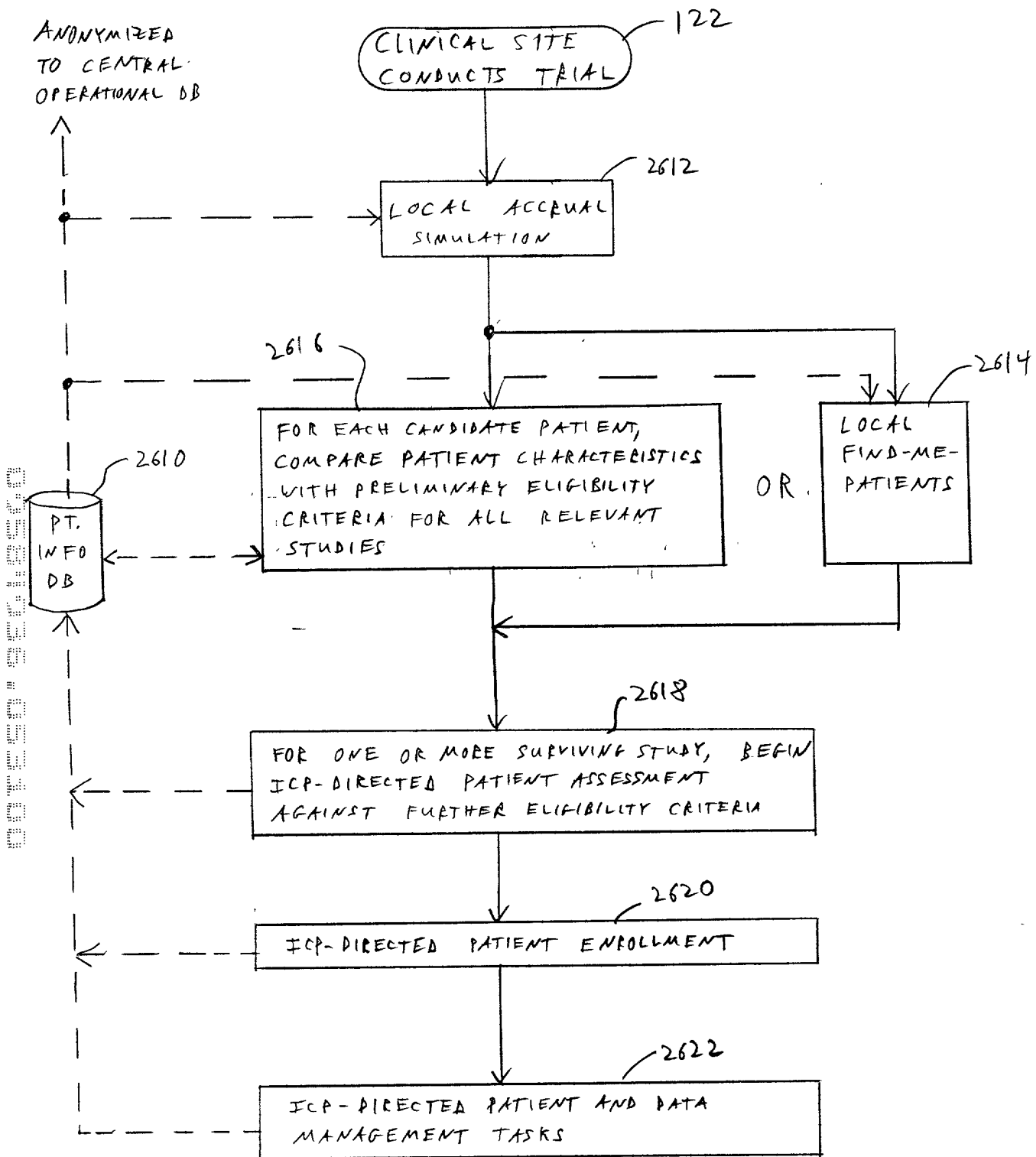


Fig. 26

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application	) <u>PATENT APPLICATION</u>
)
Inventor(s): Michael G. Kahn, M.D., Ph.D;	) Art Unit:
Michael Mischke-Reeds)
	) Examiner:
SC/Serial No.: Unknown)
)
Filed: Herewith)
)
Title: CLINICAL TRIALS MANAGEMENT SYSTEM)
AND METHOD)
)

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name; I believe that I am the original, first and sole inventor (if one name is listed below), first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

CLINICAL TRIALS MANAGEMENT SYSTEM AND METHOD

the specification of which (check applicable ones):

 ✓ is filed herewith;

 was filed with the above-identified "Filed" date and "SC/Serial No."

 was amended on (or amended through) .

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose information which is material to the examination of the application in accordance with Title 37, Code of Federal Regulations, §1.56.

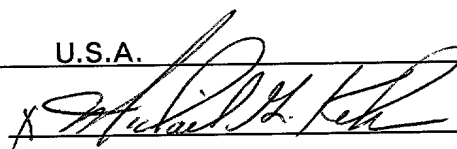
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

(1) Full name of sole
or first inventor: Michael G. Kahn, M.D., Ph.D

(1) Residence: 3980 Greenbriar Blvd.
Boulder, CO 80303

(1) Post Office Address: (Same)

(1) Citizenship: U.S.A.

(1) Inventor's signature: X 

(1) Date: X 13 May 00

(2) Full name of second
joint inventor: Michael Mischke-Reeds

(2) Residence: 44 Brentwood Avenue
San Francisco, CA 94127

(2) Post Office Address: (Same)

(2) Citizenship: U.S.A.

(2) Inventor's signature: X

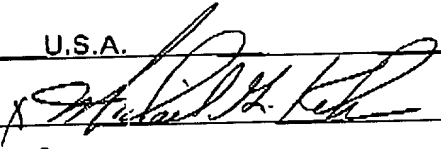
(2) Date: X

(1) Full name of sole
or first inventor: Michael G. Kahn, M.D., Ph.D

(1) Residence: 3980 Greenbriar Blvd.
Boulder, CO 80303

(1) Post Office Address: (Same)

(1) Citizenship: U.S.A.

(1) Inventor's signature: X 


(1) Date: X 13 May 00

(2) Full name of second
joint inventor: Michael Mischke-Reeds

(2) Residence: 44 Brentwood Avenue
San Francisco, CA 94127

(2) Post Office Address: (Same)

(2) Citizenship: U.S.A.

(2) Inventor's signature: X 

(2) Date: X 5/30/00

Title 37, Code of Federal Regulations, §1.56

**SECTION 1.56. DUTY TO DISCLOSE INFORMATION
MATERIAL TO PATENTABILITY**

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98.* However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

- (1) prior art cited in search reports of a foreign patent office in a counterpart application, and
- (2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office; or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

* §§1.97(b)-(d) and 1.98 relate to the timing and manner in which information is to be submitted to the Office.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application	)	<u>PATENT APPLICATION</u>
Inventor(s): Michael G. Kahn, M.D., Ph.D;)	
Michael Mischke-Reeds	)	Art Unit:
SC/Serial No.: Unknown)	
Filed: Herewith	)	Examiner:
Title: CLINICAL TRIALS MANAGEMENT SYSTEM))	
AND METHOD)	

POWER OF ATTORNEY BY ASSIGNEE UNDER 37 C.F.R. §§3.71, 3.73(b)

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

The below-identified Assignee is the owner of the entire right, title and interest in the above-identified patent application by virtue of an assignment from the inventor(s).

___ The assignment was recorded in the United States Patent and Trademark Office at Reel ___, Frames ___ - ___, or

☒ A true copy of the assignment is attached hereto, the original of which has been (or is herewith) forwarded to the United States Patent and Trademark Office for recording.

The undersigned (whose title is supplied below) is empowered to sign this statement on behalf of the Assignee.

Assignee hereby appoints WARREN S. WOLFELD, Reg. No. 31,454, D. BENJAMIN BORSON, Reg. No. 42,349, and other attorneys of FLIESLER, DUBB, MEYER & LOVEJOY LLP, to prosecute this application and transact all business in the United States Patent & Trademark Office connected therewith; said appointment to be to the exclusion of the inventor(s) and the inventor's(s') attorney(s) in accordance with the provisions of 37 C.F.R. §3.71.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Please address all correspondence to:

Warren S. Wolfeld
FLIESLER, DUBB, MEYER & LOVEJOY LLP (415) 362-3800
Four Embarcadero Center, Suite 400
San Francisco, CA 94111-4156

Please direct all telephone calls to:

Warren S. Wolfeld

Assignee: FastTrack Systems, Inc.

Assignee Type: (Corporation, Partnership, ...) Corporation

Signor's Name: Michael G. Kahn, M.D., Ph.D.

Signor's Title: (Corporate Office or Position) Vice President

Signature:  Date: X 13 May 00